





"IN THE PAGES OF GOOD BOOKS  
LIES THE MAGIC TO INSPIRE OUR  
DREAMS AND THE POWER TO MAKE  
THOSE DREAMS COME TRUE"



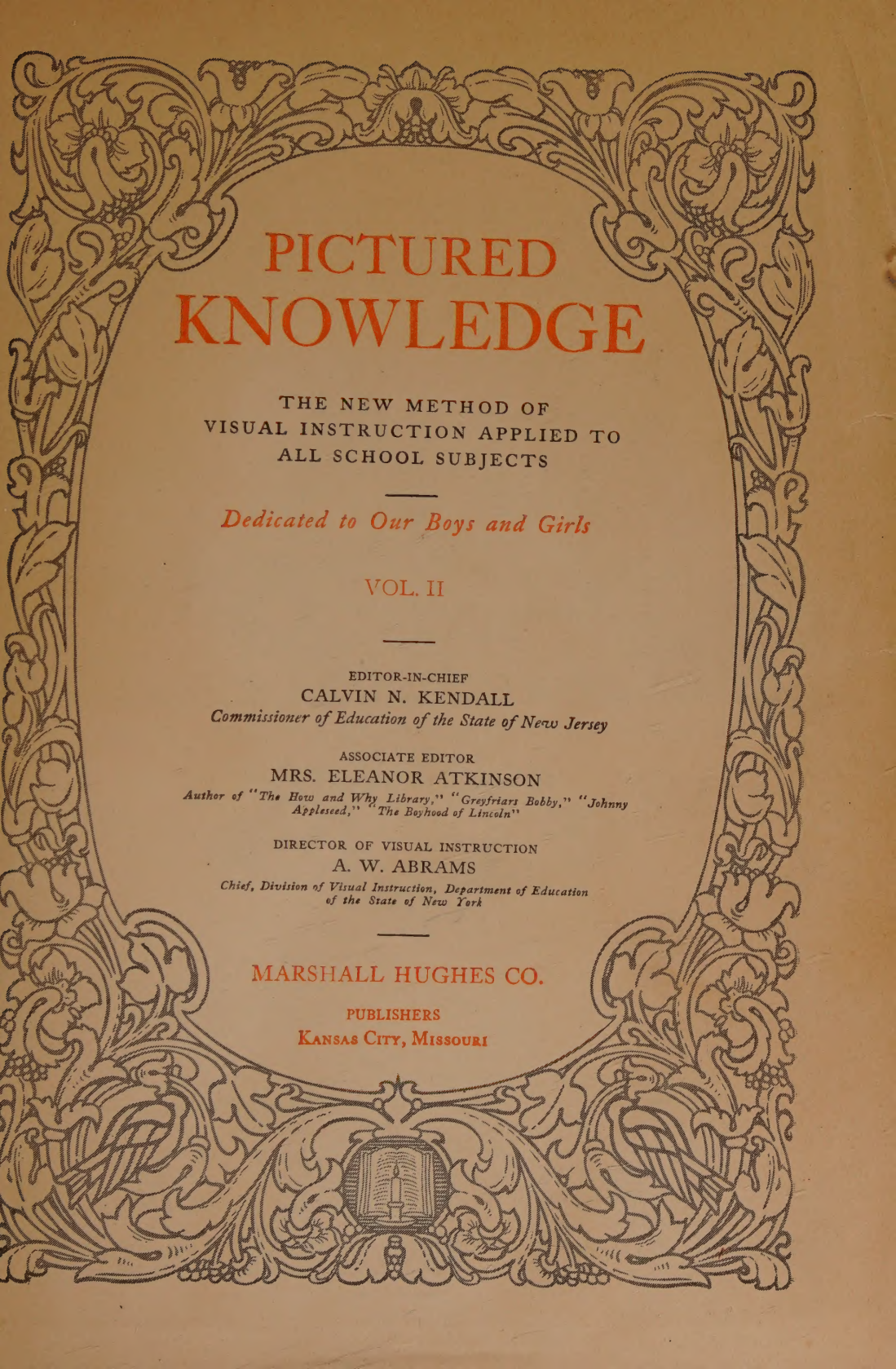


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A highly decorative border made of intricate floral and leaf patterns, framing the entire text area. At the bottom center, there is a small illustration of an open book with a lit candle on top of it, also within the border.

# PICTURED KNOWLEDGE

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*Dedicated to Our Boys and Girls*

VOL. II

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KANSAS CITY, MISSOURI

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SEEING THE WORLD  
AND ITS PEOPLES  
THE PANAMA CANAL



"That Giant With the Seven-League Boots Could Almost Step Over It"



**A**T the narrow, southern end of North America lies a little country that has played a big part in the history of the world. Only forty-seven miles wide at its narrowest point, the Republic of Panama separates the Atlantic from the Pacific Ocean. It lies across a great water trade route like a landslide across a railroad track. Really

it would be more useful if it weren't there, at all!

To go around Panama means a voyage of ten thousand miles, down to the end of South America and up again. To cross it looks easy. That giant with the seven-league boots could almost step over it. But here Nature has heaped up so many troubles for travelers that Spain, France



# How the Panama Canal Gives



These two maps show the principal trade routes of the world and how some of them are shortened by through the Suez Canal, as was at one time feared.

and the United States puzzled over that problem for four hundred years. It was not solved until 1913, when the Panama Canal was opened. The enormous water bridge which now spans this narrow neck of land is called Uncle Sam's "Big Job." The doing of it makes the greatest of all stories of victories of peace.

The story begins with Columbus,

who discovered the eastern coast of Panama in 1502. He was hunting for an ocean strait that would let him through to China. Eleven years

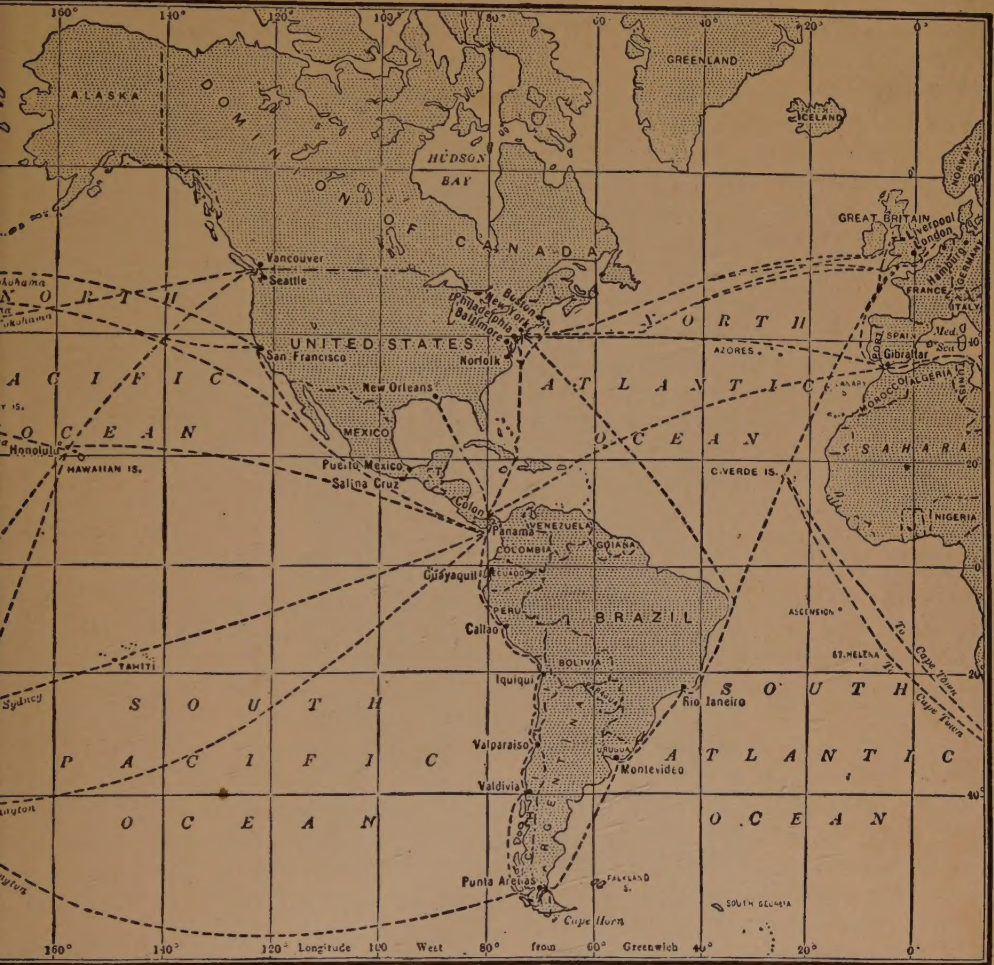
later, another explorer from Spain—Balboa—crossed the isthmus, at the head of armored troops and conquered Indians. He was in search of treasure, and was quite unaware that a few days' march would bring

*A Great  
Victory of  
Peace*

*Balboa's  
Discovery of  
the Pacific*



# a Short-Cut Across the World



the Panama Canal. From this map it will be seen that the Panama routes do not interfere with those

him to the shores of another great ocean. It was on the tenth of October, 1513, that he climbed Balboa Hill, after crossing a low mountain range and, as a poet says—with eagle eyes stared at the Pacific—and all his men

*Looked at each other with a wild surmise,*

*Silent upon a peak in Darien.*

Such an astonishing, important discovery! Here was a new ocean

for Spain to sail; new lands, beyond, perhaps, for her to conquer. How vexatious that ships should be stopped by such an insignificant strip of land!

*Balboa's Dream of the Canal*

Balboa reported to the king that he thought a strait could be opened across this isthmus. "There be mountains," he admitted, "but there also be hands to level them." Those early explorers were



men of vision and daring. No task looked too big to them.

**Mountains, Swamps, Jungles and Eleven Feet of Rain!**

"There be mountains," indeed, and other difficulties to daunt the stoutest heart, in Panama. The tip-end of our great western highlands, we find here the same central plateau and a true mountain range. To

be sure this pygmy table-land is only thirty-two miles wide and eighty-five feet high, and the ridge which springs from its western edge rises to a height of only five hundred and thirty-four feet, but it is a part of the rock-ribbed, folded and wrinkled backbone of the continent. As elsewhere, from Alaska southward, the slope to the Pacific is short and steep. The eastern slope descends to a region of rough foothills on the plateau, before it drops to the sandy swamp which borders the coast.

In this hot, sea-washed land, eleven feet of rain falls every year. Storms from the Caribbean sweep

right over the low mountains, drenching the isthmus and causing a dense growth of tropical jungle nearly everywhere. The eastern coastal belt, for a width of six or seven miles, is bottomless swamp. Above that, the foothill valleys of the plateau are netted with swollen streams that, uniting, drop in raging little torrents to the sea. The Chagres River, before it was dammed back by the canal builders, and made to spread into a lake on the plateau, often rose forty feet in twenty-four hours. "There be mountains," floods, swamps, poisonous snakes and insects, and steaming

jungle in Panama for men to conquer.

The Spaniards did cut and burn, hew and bridge, and keep open a royal road between the fortified cities which they built at Panama and at San Lorenzo at the mouth of the Chagres. Their ships were soon on the Pacific bringing treasure from Western Mexico, Peru, South America and the Philippine Islands. Treasure was carried overland and supplies returned by mule-trains of hundreds of laden animals guarded by soldiers. Indians and English pirates often attacked and robbed these trains. The early story of Panama was one of splendor and violence.

*Spanish Traffic Across the Isthmus*

**The Sluggish River and the Jungle**

On the lower Chagres River you can, today, see the stream they navigated, and the tropic forest through which these Spanish adventurers broke. A power-boat takes tourists for a trip westward for ten miles along the coast from Colon, to see the vine-smothered ruins of old Fort San Lorenzo. From there it chugs up the river to Gatun Dam which has been built across the stream on the edge of the plateau.

A sluggish river, now that it has been tamed by the dam, it flows between the green walls of the tropic forest which springs from the water's edge. There are no banks. A rise of twelve inches floods the bordering land. At all times, mangrove trees wade out on their stilt-like roots, on which snakes and alligators sun themselves. Those forest walls, which rise higher than the two-hundred-foot width of the river, look to be only screens of green and gold lace—ferns, sensitive plants, flower-

*Swamps, Jungles and Eleven Feet of Rain*



ing shrubs, delicate creepers and slender saplings. But from earth to tree-tops, there are shafts as tall as light-houses, with gleaming, candle-like blossoms—everything is woven into a mat by vines as tough as wire and rope, and beset with thorns and prickles. No man or large animal can force a way through. Above are brilliant birds, monkeys and climbing snakes; and below, in the moss and fungi-carpeted bog, are alligators, lizards and other reptiles. And such color! Bright purple and yellow trees, thickets of scarlet hibiscus, and orchids in airy, multicolored flocks like butterflies. Swarms of stinging insects, in burnished metal colors, are thrown out upon the forest screen like spray from a sea of life. It fills the eye with dazzling beauty and the heart with fear.

The natives of Panama, and nine-tenths of the four hundred thousand people of this little republic, which is smaller than the state of Indiana, are still of Indian or mixed blood. You can see them on the Chagres in the cayucas, or hollowed tree-trunk canoes, such as they used in Balboa's day. Sitting carelessly, or

even standing erect, they propel these boats skillfully with long poles braced against trees or the river bottom. They even venture out in

## A Lighthouse in the Forest



The lighthouses around Gatun Lake are part of the wonderful lighting system of the canal. They were built before the Gatun Dam was completed and stood, at first, in the midst of the forest. After the Chagres was dammed, the water spread out to where the lighthouses stand.

foaming floods and shoot dangerous rapids. They build their palm-thatched huts on upland bluffs and, planting a few banana trees and cultivating a patch of yams, take life easy. What little money they need for their scant clothing can be made by catching parrots for the northern market; hunting the iguana, an edible lizard; fishing for the shell tortoise and diving for pearls on the west coast. The Spanish people are traders in the coast towns, or they grow coffee, vanilla beans or indigo, manage stock farms, or operate gold

mines in their primitive way.

## The French and the Canal

These people, too, like the Mexicans, won their freedom from Spain and then impoverished themselves by long civil wars. With some such leader as President Diaz they might, themselves, have built the railroad which an American company carried across the isthmus after gold was discovered in California in

1849. Passengers who were saved the long voyage around Cape Horn, or the caravan trip across our thousand-mile-wide mountain and desert region, cheerfully paid \$25 fare to be set across Panama. So much money was made by the railroad that a French company was formed to dig a canal.

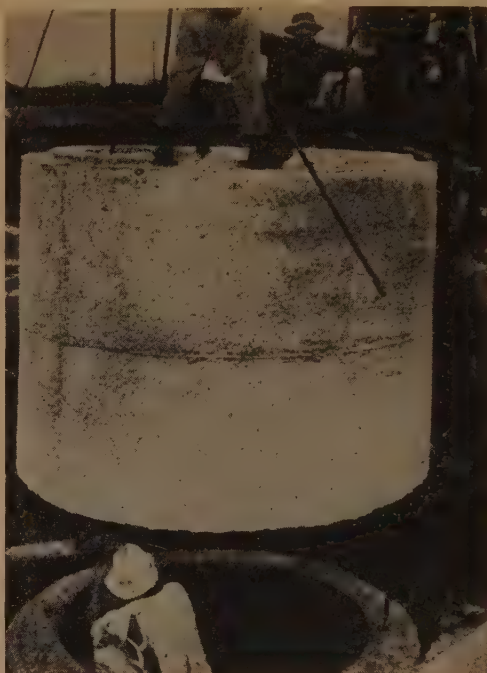
#### How the French Began the Canal

The French were not frightened by the fearful human cost of that railroad. Engineers knew how to cross mountains, bridge torrents and level forests. But never before had a firm road-bed been made

#### Alligators and Snakes Looked On

across a seven-mile-wide swamp, two hundred feet deep in ooze. Six thousand men died of yellow, malaria and typhoid fever, between Colon and the edge of the plateau—a life for every tie laid. Men worked, standing in rotting mud to their armpits, amid clouds of poisonous mosquitoes and flies. Alligators and boa constrictors looked on from logs and over-hanging trees, as they slept or ate their lunches. But that necessary task was done. Aren't you proud of such brave men?

The Foundations of the Balboa Docks



Balboa, the new American town on the western side of the canal, has fine docks that can give the best of accommodations to passing ships. These workmen are sinking a cement caisson, one of several that form the foundations of the dock.

Then, M. De Lesseps, the famous engineer of the Suez Canal in Egypt, toiled at the Panama waterway for a quarter of a century. He

sacrificed twenty thousand lives to tropic diseases, and spent \$260,000,000. Panama got such a name as a pest-hole that men fled from it in terror. The company bankrupt, De Lesseps went home, old and broken-hearted, leaving his buildings, machinery, half-dug ditch, and acres of little white head-stones to mildew, rust, flood and pitiless jungle.

#### Then Uncle Sam Rolled Up His Sleeves!

The people of the United States were sorry that the French failed, but they were not discouraged. We needed that canal, and it must be finished. Our Pacific Coast, three thousand miles overland from the Atlantic, was becoming thickly settled. Alaska was developing; and we had islands, east and west, and a growing trade with China, Japan and the west coast of South America. To be sure we had four transcontinental railroads by that time, but land freight rates for such long distances are too high

#### The Canal and the Railroads



## A Big Dipper Dredge



Courtesy Scientific American © Munn & Co

Thirty-four men are standing in the cup of this hydraulic dipper dredge. The dipper can pick up, in one mouthful, fifteen cubic yards or twenty tons of soil. It is eleven feet high and the arm carrying it is seventy-two feet long. Beside cutting down the side of a hill, the dipper can dig out soil fifty feet under water. This dredge has another dipper of ten cubic yards capacity. There were two of these monsters at work on the Panama Canal, and together they took out about six hundred thousand cubic yards of material a month.

for such bulky things as wheat, lumber, coal, rice, crockery, cotton, machinery and furniture. With a shortened voyage many useful things could be carried cheaper by water. Besides, in a big war, we might need to move our naval vessels from one ocean to another very quickly.

Here was the "big job" that could be done only by a big, rich, ener-

getic and inventive nation. So the United States bought the Panama railroad, and the canal works and rights of the French owners, paying \$40,000,000 for them. And we

*Purchase of  
the Canal  
Zone*

paid \$10,000,000, and a yearly rental of \$250,000 to the Republic of Panama for the privilege of finishing the waterway, and for the lease of

### A Culebra Cut Landslide



© Keystone View Co.

A landslide begins as a big crevasse or crack in the earth. This is part of the embankment at Culebra Cut, showing the beginning of one of the many landslides here.

a ten-mile-wide strip across the isthmus—the Canal Zone. We also secured the right to clean and enforce health rules in the reeking old Spanish cities of Colon and Panama.

We did not propose to let *our* workmen die like flies. We had learned that tropical towns could be made healthful by

*Making the Canal Zone Healthy* draining and paving them, supplying

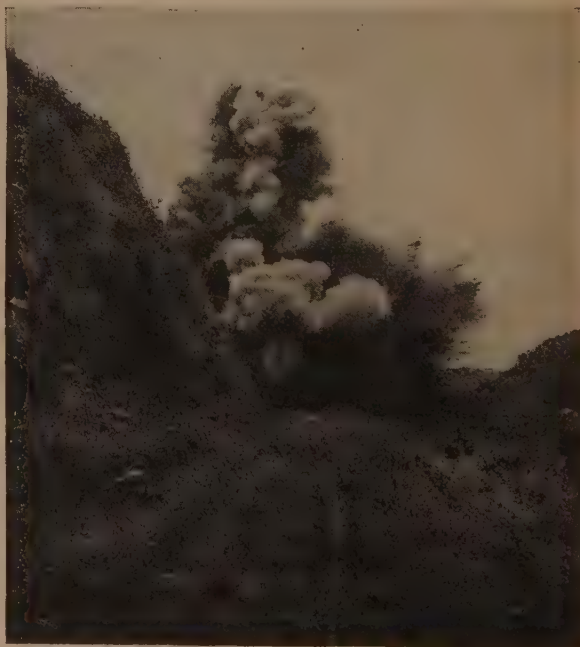
pure water from the hills, and killing flies and mosquitoes. After our war with Spain to free Cuba, Colonel Gorgas, an army doctor, made Havana as healthy as any northern city. He was sent to the isthmus. Read our story of him and learn how he con-

quered disease and death in the Canal Zone. When that was done an army of workers swarmed in through Colon. There were commissioners, engineers, electricians, draftsmen, foremen, telegraph line-men and operators, railroad crews, machinists, blasters, dredgers, cement-mixers, health officers and nurses, teachers, stenographers, clerks, mothers with their children, and thousands of laborers, black and white.

### What Colonel Goethals Did

Temporary towns had to be built with dwelling houses, hotels, schools, offices, stores and hospitals. The railroad was partly rebuilt and supplied with new cars and locomotives.

### Like an Earthquake Shock



This is the explosion of a one hundred and eighty-pound charge of dynamite, used in blasting out a hillside.



## Why the Canal is a Wonderful Feat of Engineering



© Keystone View Co.

Here are ten million cubic yards of earth lying across the partially dredged channel of the canal. It was landslides such as this one, entirely blocking the canal, that gave the engineers so much trouble.

### Eating Up a Hillside



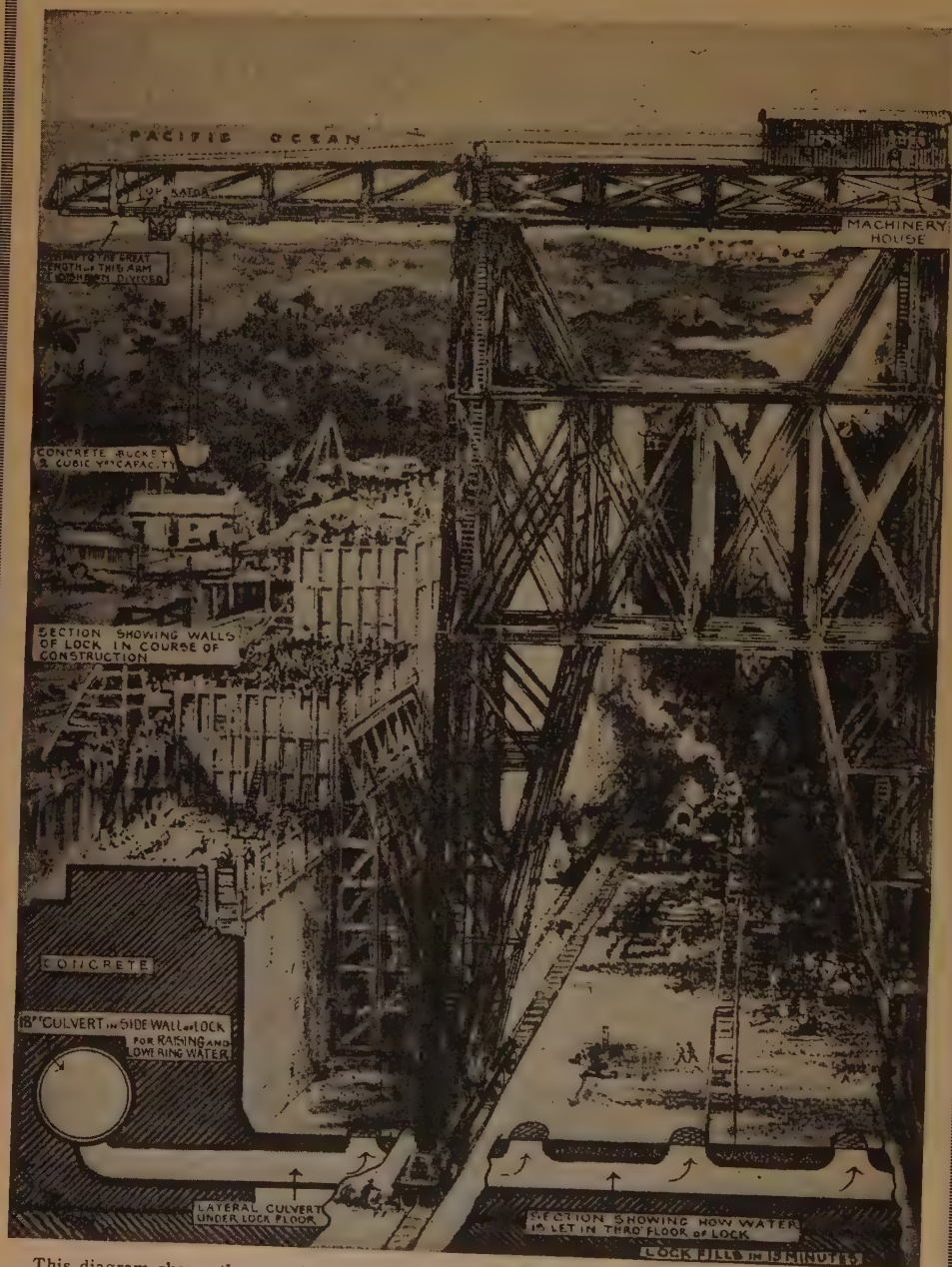
© Keystone View Co.

Here is a steam shovel taking a good-sized bite out of a hillside at Culebra Cut.

Then Colonel Goethals, an army engineer, was made "Boss of the Big Job" and the dirt began to fly. You must read our story of him, too, and learn how a great commander of men, when given the power of a Czar of Russia, gets things done.

With \$400,000,000 Partly, too, and the Man because of the vast amount of useful work done by the French, the task was completed in nine years, at a cost of less than \$400,000,000. Together France and the United States have poured more gold back into Panama

## How the Locks Were Built



This diagram shows the movable scaffolding used to build the locks at Panama. A cross-section of the half-finished lock is shown at the left of the picture. There are three pairs of these locks, each 1,000 feet long, 110 feet wide and 43 feet deep. They are the finest ever built. These culvert and passageway at the side, leading to the opening in the floor, are built in the solid concrete and will fill the lock with water in fifteen minutes. One of the cars on which the scaffolding is mounted can be seen on the track at the left.



than the Spaniards took out of Mexico and Peru. And we have made something of priceless value to the world, while the Spaniards only destroyed.

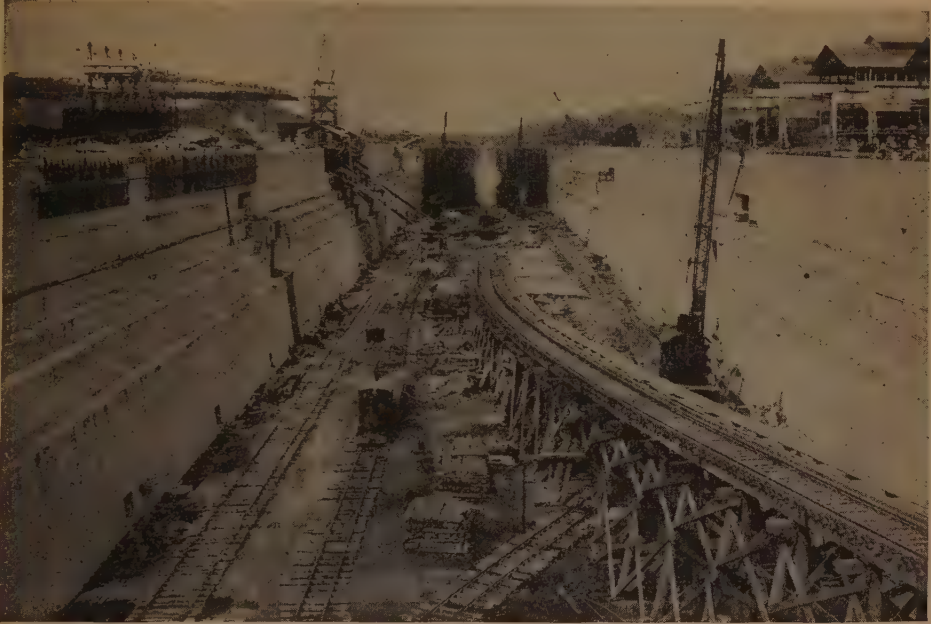
So it was we who truly celebrated Balboa's discovery. It was on the

public of Panama marked it by putting a new motto on its official seal: "A Land Divided, The Oceans United."

**How the Great Work Was Done**

Presently we will take a trip

**The Dry Docks at Balboa**



This is a view of the Balboa dry docks looking toward the water gates. They are part of Balboa's equipment for accommodating and repairing ships.

tenth of October, 1913, four hundred years to the day, that President Wilson in the White House in Washington, opened the Panama Canal by pressing a telegraph key.

*Opening of  
the Big  
Ditch*

A spark flashed over land wires and sea cables, setting off a charge of dynamite that blew out a temporary dyke. A flood rushed through a rock-walled rift in the mountains. The waters of the Chagres River, of the Atlantic slope, fell down through locks to the Pacific. The first boat to go through was a native cayuca. A red-letter day for all the world, the little Re-

through the Panama Canal, so you will want to understand what you will see. The engineers did think of cutting a sea-level channel, or true ocean strait. But, besides the great amount of blasting and digging to be done—a truly appalling task—land-slides and floods might

*The Digging  
and the  
Dynamite*

have been impossible to control. In making the lock canal, the natural levels of the land were used. Deep dredging opened channels across shallow bays and swamps. On the plateau the foothills along the right of way, and the mountain range, were blasted out with dynamite.

## The Gatun Spillway



As you enter the lake you can see the Gatun Dam, which holds all these waters on the plateau. An enormous embankment a mile and a half long, it connects two natural hills. At its center is another hill, whose solid rocks have been pierced and lined with cement to make the spillway for the escape of flood waters into the lower Chagres. Fifteen thousand cubic feet of flood water a second is plunging over the spillway.

The straggling basin of the upper Chagres, banked by its own bordering hills, was then turned into a lake, by building a great dam across the river on the eastern edge of the plateau. The engineers thus avoided having to cross and re-cross the Chagres River, and they also secured an enormous elevated reservoir of water to supply the locks. This lake is kept at one level no matter how heavy the rainfall, by letting surplus water escape

*Making the Stairs for the Ships to Climb* through a spillway, in the middle of the dam, into the lower Chagres.

From the eastern and western edges of the plateau, ships are lifted and lowered through three great pairs of locks. Our Canal is, really, a water-bridge. Water stair-steps lead up to a center span which, thirty-two miles in length, is lifted

eighty-five feet high and carried in a low arch across the isthmus.

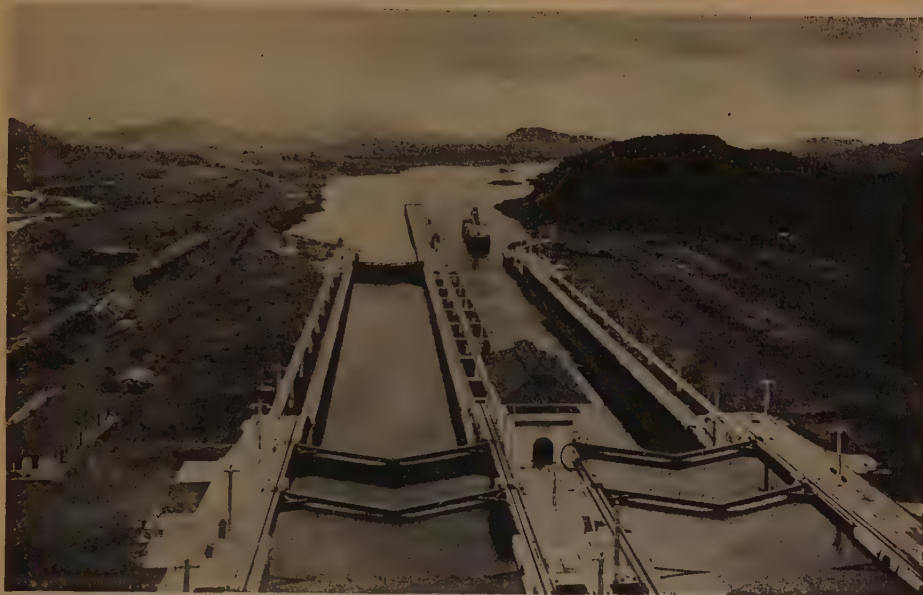
Let us imagine that we have taken a steamer at New York, sailed down the Atlantic Coast, passed the West India Islands and run across the long rollers of the Caribbean Sea.

*Here We Go Through the Canal!* It is as blue as indigo. On every shore fringed with cocoa palm trees,

it breaks in foam-crested waves. Passengers rush on deck, when the watch reports "Toro Light." This is the light-house on Toro Point which guards Limon Bay. Behind the long break-water, the Panama Canal begins, three miles out in the Caribbean. A channel, five hundred feet wide and forty deep, was dredged out of this shallow bay. The harbor is covered with ships. Big freighters, passenger steamers, war vessels and pleasure yachts, un-



## What the Locks Look Like



Entering the Miraflores Locks from the South



The Miraflores Locks Looking North

## The Panama Locks and the

1. The central board from which the lock mechanism is operated. The board is a miniature reproduction of the lock it controls.

2. The gate-opening machine which is started and stopped from the control boards.

3. A conduit for electrical connections.

This model of the Miraflores lock shows how the great water gates are opened and shut to let the ships through and how the water is controlled so as to help them climb up the water stairways and then climb down again.

The "operating board" at 1 has on it what you might call "toy" reproductions of each part of the machinery; a kind of picture language which will help the operator to remember just what he is doing. One of these little reproductions is called a "chain fender." This chain, under the operator's eyes, rises and falls with the big lock chain shown at 7. Another device has

a slab of blue marble, to represent the water of the lock. Across it reach the leaves representing the big gates; and they open and shut just as if they were consciously imitating the



Courtesy Scientific American. © Munn & Co.



# Wonderful Mechanical Brain



4. The transformer room.

5. An electric towing locomotive.

6. The intermediate lock gate.

7. The hydraulically operated fender chain which prevents the ship from colliding with the lock gates.

locomotive has similar indicators to show the pressure of steam and the amount of water in the boiler. But—most wonderful of all—is what might be called the “automatic brain,” that part of the mechanism which compels the operator to move his levers in just a definite order. He cannot make a mistake. All he is needed for is to set the machinery in motion when needed and to stop it. This “brain” is underneath the control board, and

is called an interlocking system. Step No. 2 can't be taken until Step No. 1 is finished, just as you can't open a door until you turn back the bolt, and you can't turn the bolt until you insert the key.

big water gates. Another device is like a thermometer—a tall, slim tube, in which an indicator rises and falls as the level of the water in the canal rises and falls. The engineer in a

## The Navy Needed the Canal



"In a big war, we might need to move our naval vessels from one ocean to another very quickly." Here are the "Missouri" and the "Ohio," United States battleships, going through the locks. The picture gives you a good view of the "four electric locomotives on the walls, that are hitched to bow and stern and pull the ship into the lock."

der gay flags of a dozen nations, take their place in the processions passing into and out of the Canal.

On the left you can see the white houses and red roofs of the old Spanish city of Colon under the palms, and on the right, the warehouses and docks of the new American port of Cristobal. Cristobal-

*And Columbus Looks On* Colon is French-Spanish for Christopher Columbus. The palace built for De Lesseps, the French engineer, stands here, and the bronze statue of Columbus—a gift to Panama from the Empress Eugenia. The ships of the world pass under the eyes of the great navigator. Here, at last, is his ocean strait.

### Into the First Great Lock

Our ship steams across the low coastal belt. The tropical forest has

been pushed back; but we can see it on either side, a green and blossomy ocean engulfing the land. Then the shores begin to rise, and the waterway to bore into the hills. Suddenly a wall of cement and stone blocks the way. This is the gate of

*First Step Up the Water Stairway* the first lock, or double gate. The right-half of

it opens in two wide leaves against the side walls, for here the channel is divided by a center wall, for incoming and outgoing ships. The engines of the vessels are stopped here, and four electric locomotives, on the walls, are hitched to bow and stern and pull the ship into the lock. The gates close behind, shutting the vessel into a thousand-foot-long chamber. Water let in from above lifts the ship to the level of the water in the next lock. Then the upper



## A Bird's Eye View of the Shortened Routes



This is how the canal would look if you could get a bird's-eye view of it. It shows you how the ships climb to Gatun Lake and go down again on the other side. Find the railroad that runs along, roughly parallel to the canal, from Colon to Balboa.

Here you also learn more about the "short cut." It brings Liverpool and San Francisco 6,000 miles nearer together, makes the trip from London to Honolulu 4,500 miles shorter, and cuts off 8,000 miles of the distance between New York and San Francisco.

gates are opened. Three steps lift the ship eighty-five feet. On leaving the last lock the engines start again and the vessel is off, full speed, for the twenty-four-mile run across Gatun Lake.

To the right, as you enter the lake, you can see Gatun Dam which

of flood waters into the lower Chagres. The dam was filled in with rock and earth blasted out of the foot-hills and the mountain range.

In crossing the lake the Canal makes eight turns, following the old valley of the Chagres River, where a channel five hundred feet wide has

A Baseball Game Under the Palm Trees



The blistering, tropic sun is not too hot for the enjoyment of baseball. The trees surrounding the diamond are cocoanut palms. The picture was taken at Toro Point and shows a hotly contested game between the Culebra and Toro Point teams, in which the former won.

holds all these waters on the plateau. An enormous embankment a mile and a half long, it connects two natural hills. At its center is another hill, whose solid rocks have been pierced and lined with cement, to make the spillway for the escape

*Passing the  
Gatun  
Dam*

been deepened to forty feet. Ships are guided by range-lights, in pairs of concrete towers sixty feet high, as are automobiles by arc-lights on a city boulevard. All the lamps are on one circuit and are lighted by pushing a button. The electricity

*The Brilliant  
Water  
Boulevard*



for lighting the Canal, operating the hidden machinery of the locks, and running the towing locomotives on the walls and partition of the locks, is supplied by the water-power at Gatun Dam. At night the Canal, from ocean to ocean, is a brightly lighted water boulevard, bordered by the beautiful tropic wilderness. A palm-thatched hut perches on every hilltop, the cayuca darts in the wake of the steamer, groves of drowned trees lift their heads above the waters of the lake, quite dead but still draped with vines and Spanish moss.

#### Through the Famous Culebra Cut

From Gatun Lake the Canal passes into Culebra Cut. This is that mighty rift in the mountains. Three hundred feet wide at the bottom, it slopes up to towering cliffs that are, already, covered with tropical vegetation. Dynamite blasted out the rock here, rending the ridge like earthquake shocks. Those explosions may have loosened layers of clay and soft stone, for there were troublesome landslides.

Through one lock our ship drops down from Culebra Cut to Lake Miraflores, two miles wide. Two more locks lower it to tidewater. From the Canal we can see Balboa Hill which the explorer climbed to "stare at the Pacific." It overlooks the bay of San Miguel, and the new American port of Balboa. A trolley line runs down the coast to Panama City, the old Spanish capital, a

ragged, gay, bright-colored, degenerate old tropical town; but cleaned, drained, paved and healthy for the first time in its four hundred years of history.

#### Balboa, the Canal, and the Future

It is believed Balboa will grow up into the greatest of all tropic seaports. Here are docks for ships, dry-docks for repairs, coal docks, machine shops, warehouses, a naval station. And out on the three islands which guard the bay the United States has forts to defend the Canal.

Look back as you steam out into the Pacific. The shore seems to spring abruptly from the water. There is no sand beach, no jungle. Pearl divers drop from boats into the bay. Cattle graze on the clean, grassy slopes. There is gold in the mountains. From the bay the ships spread like the ribs of a palm-leaf fan, going north, west and south, to California and Alaska, to China, Japan, the Philippines and to South America. Seven hours, now, to cross the Isthmus by our water bridge, and they are away again to all Pacific ports.

Here is the stage setting for a great drama of human achievement. It was there to be conquered. For four centuries it enlisted dreams, genius, courage, sacrifice, treasure, wounds and death. In all its lovely length our Isthmian waterway is guarded by the memories of brave, devoted men.

## What Strange Land Is This?

A Remarkable Community of Millions that Is Not Even Mentioned in Your Geography or History. They Have Machines that Run and Repair Themselves, Cameras that Take Pictures in Colors, Telephones that Record Sounds, Policemen that Never Fail to do Their Duty, Citizens that Love One Another Better than Themselves and Many Other Things You Would Hardly Believe.

SOME years ago there was located near Oneida, New York, a community of about three hundred people who formed a commune; that is, they shared equally in the work and in the responsibilities, and also shared equally in the gains and privileges.

This commune did not succeed financially, and after some years disbanded as a commune. There are, however, other communes which have succeeded in their plan of co-operation. In these communities there are not only three hundred members, but more than a million members, all sharing equally. These communes are all so similar in their plans and methods that if I describe one you will readily understand them all.

The members of this community are divided into groups according to the work which they can do the best. These groups are again divided so that each group attends to a certain part of that kind of work, and these again into smaller groups which correspond to our families, but who are, however, not families.

### What a Lot of Clever People!

Each group of workers is made up of specialists in that kind of

work. In fact, they can do that particular thing better than it is done anywhere else or by anyone outside of these communities.

Everything used by these groups must be made within the community. Moreover, having such well educated and thoroughly prepared workmen, they are able to produce as fine an article as can be made. It is not only because they have such superior skill that they prefer to make all their own food, but because, being peculiarly constituted, they require a liquid diet even though they are neither babies nor invalids.

Think how much work it must entail to feed millions of people on a liquid diet which yet must contain all the same elements of food which we need; starches, sugars, albumins, fats and salts. These foods must pass through a mill to be ground and must be shaken up with liquid much as you shake up an egg lemonade. In short, the form and condition of all food used in the community must be changed and mixed with water until it is about as thin as milk.

It takes many factories working night and day to grind such an immense amount of liquid food.





As there are no horses or wagons, no automobiles, street cars nor trains in these communities, they have devised another way of transporting things, which we shall tell you about after we have seen some other parts of the community.

## Where is This "United States"?

While no one person can be said to be ruler of the commune, yet there is a group of individuals who govern the whole body, with the help of many other groups. These individuals

*Each for All* and *All for Each* were especially trained for this work and are so devoted to the interests of the community that they practically live in their places of business, work in harmony and prevent friction.

No doubt you are wondering why you have never heard of these wonderful individuals before, and wonder, too, where these communities are located. Perhaps if I were to call them by name you might remember having heard of them, but did not know they were communes. And as for their locations, that is the funniest part of it all, for they are not located in any particular place, but are nomadic—that is, they go from place to place as it seems best for the community.

If the governing group receives word that a particular locality is lacking in any respect, information is sought at once as to a better place for that special thing, and when the information is received the order is

*New Settlements to Order!* given for the movers to take charge and move the community to this better place. These movers are so skilful and hold themselves in such perfect readiness that they begin to move as soon as the order is received

and yet disturb none of the activities of the commune.

When a new location is chosen everything goes — mills, factories, telephone, telegraph and electric plants.

In every new location pictures are taken by color photography, of everything in sight—bad as well as good things. These photos are used

*The Music and the Picture Show* later to instruct, to entertain and to amuse the inhabitants, and are kept stored in one of the offices of the governing body, which body decides when and how they shall be used.

In addition to this, there are trained listeners who make a business of hearing all that is said and of making records of music, lectures, dialogues, bird songs, etc., to recall to the community its past experiences and to give it pleasure.

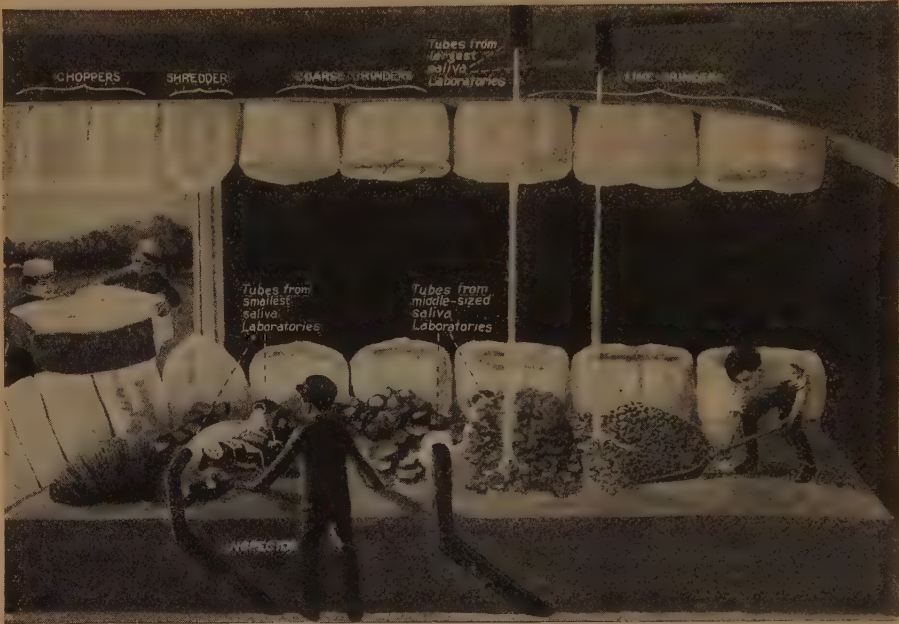
## Where Everything Goes to Mill

It will be worth your while to spend some time in visiting some of the factories. Let us go first to the mill which is always placed at the main entrance of the community. Here you will find busy workers approaching the mill heavily loaded with foods of various kinds, all of which are to be ground in the mill. You remember that these community people, living wholly on liquid as they do, grind not only their coffee and their grain, but everything which they use for food—meat, vegetables, fruits and eggs (after the shells are removed, of course).

## The "Safety First" Policy

Do you remember how kings, in olden days, used to keep a taster to taste all the king's food and drink before he touched it? This was done to see that it was not poisoned.

## The Community Mill



Here we see some "grist" being brought to the community mill—a nice piece of bread and butter. The sharp choppers cut it into large blocks. If it were a piece of meat the shredders would tear it up. Notice that the little inspector who represents the sense of taste in the tongue is right on hand to see that the grist is of good quality. On either side are the tubes leading from the saliva laboratories, and these begin pouring the saliva on the food as soon as it gets into the mill and continue until it passes out and into the kitchen. The grist keeps getting finer and finer as it proceeds on its journey, being treated first by the coarse grinders, and last of all by the fine grinders. All this while the little mixer, the tongue,—represented by the figure with the shovel—is turning it over and over and passing it back and forth so that the digestive saliva may be thoroughly mixed with it.

Well, although this community we are talking about is a republic, and not a kingdom, it has a somewhat similar system. There are two groups of sharp-eyed inspectors, one group of keen tasters and one group of expert smellers who give judgment on all foods brought in to be ground, and refuse those which do not come up to their standard of value.

Having passed the censors, the different foods are emptied together into the hopper to be ground. The grinding process is somewhat like the old-fashioned grinding between two stones and somewhat like the modern roller process, yet better

than either. During the grinding the foods are moistened by an alkaline fluid which is manufactured right in the mill by chemists who do nothing else. This alkaline fluid is poured continually and automatically upon the food so long as the mill is working, and changes the starches to sugar. After one set of stones has ground the mixture, a group of muscular individuals toss it about to mix it well and carry it to another set of stones to be ground still finer. When it has become a creamy, paste-like mass it is sent to a central room, from which it enters a long dark passage leading to the kitchen.

Opened  
By  
The Censor



## A MARVELOUS COMMUNITY

This first factory produces only acids which change albumins (egg, nuts, lean meat, beans, cheese, etc.) to a digested form, the dwellers in this commune being able to use only pre-digested foods. Here the chemists separate out the foods, digest the albumins and pass them on, together with the sugars and fats and any left-over starches, to the next factory.

In the second factory the chemists deal only with alkaline fluids and with these they change the starch left-overs and emulsify the fats. Do you know what emulsify means? It means to separate the globules of fat from each other and hold them suspended in the liquid as the cream globules are suspended in milk, making it white in color.

The chemicals for use in this second factory are not made there.

*The Laboratories and Their Pipes* They are so complicated that they have to be made by special chemists in neighboring laboratories from which they are sent to the factories in pipes.

After the food materials have been through the mill, have been treated by the chemists in the two kitchens or factories, and have been mixed with water, they are ready for the use of the community.

### The Wonderful "Town Pump"

To transport liquid, perishable food to so many consumers in a place where there are no so-called modern conveyances is a big problem, yet these keen thinkers have solved it in a perfect way. They have devised a system of tubes through which the liquid is pumped by a double-chambered pump to every part of the community. When the prepared food passes out of the second fac-

tory it is forced into a long tube where it comes in contact with various fluids. The walls of this cylinder are furnished with numberless tiny holes through which the liquid passes into very small tubes, groups of which unite to form larger tubes which later unite in one large tube which carries the liquid to the pumping station.

This perfect pumping station not only sends the liquid food to every group in the community, but it furnishes its own power and keeps itself in repair.

You would expect that anything so important as the pumping station upon whose activity all the members depend for food would be under the management of the head office, or, indeed, be located in the capital itself, but that is not the case. It is much more convenient for the pumping station to be near the food factories which send a constant stream of food to be distributed by the pumping system. Curiously enough, the pump is not even managed by the main office, but rather by one of the self-governing relay stations which tends exclusively to this piece of business. You see, so important a thing could not be left to a busy office where many other things are being done, for fear it might be forgotten in the midst of

*A Pump That Never Stops* so much work. If the pump should stop work, a part or all of the community might die of starvation. If it should stop for only one minute, the various parts of the community would be gasping for air or oxygen; while a stop of five minutes would probably cause the destruction of the whole community. You remember that they have no supply stored up

for such an event, but live from hand to mouth, drawing their food supply from the liquid as it flows past.

### "A Little Fresh Air, Please!"

As soon as the liquid pours into the pumping station it is all pumped by one chamber of this pump into a large tube leading to what we may call the "air station." This air station is a double compartment divided up into as many rooms as a sponge is full of holes, and more.

The air station is a laboratory where the liquid is mixed with air. In other words, the food is oxidized, so we may call these factories the oxidation laboratories. The mem-

*Taking  
Oxygen in  
Their Food*      bers of these communities need oxygen as much as you do, yet curiously enough, they can use it only after it is mixed with the liquid food.

In order better to understand what is being done in the oxidation laboratories, let us go back to the gate and see how the air is brought in.

Whenever the community takes up its residence in a new place, the surrounding air is tested. If it is very offensive an effort is made either to remove the community or to purify the air supply in some way. The air enters through the community wall by two openings placed high in the wall.

### Where Every Day Is "Dusting Day"

Here the air is tested and passed through soft brushes which catch and hold all dirt particles. The dirt-free air then passes into a central room and, through a door which opens to admit it, into a passage leading direct to the oxidation laboratory. In this laboratory the chemists separate the oxygen from the air

*Brushing  
the Dust Out  
of the Air*

and empty it into the food as it comes from the pumping station. The change in the food-stream produced by the addition of oxygen is wonderful. From a dull, lifeless liquid it becomes brilliant and beautiful. It is again sent back to the pumping station, this time to the second pump chamber, which pumps it to the remotest part of the community as well as to the nearby groups. It is carried in tubes of gradually decreasing size, like those of a city water system. The smallest pipes go to the family-like groups where each individual draws out what he needs and no more.

### The Pleasant Land of Plenty

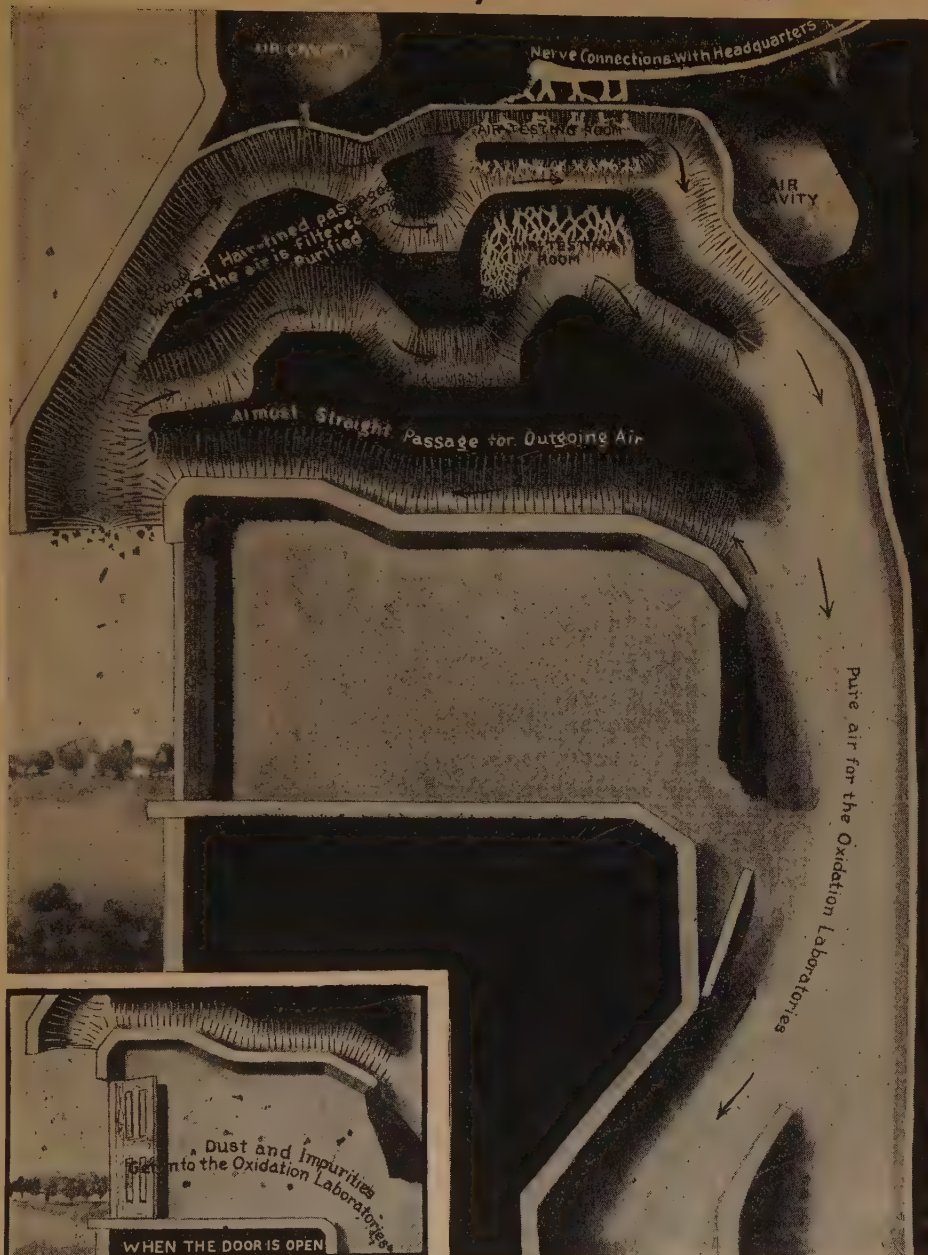
It is of no use for one to take more than he can use, for under all normal circumstances there is an ever ready supply. *Where Nobody is Ever Greedy* Some few groups do try to store up a supply for emergency, but it is not good economy, for it hinders their work and is in the way.

Nothing has yet been said regarding the sewerage. It stands to reason that there must be waste from the factories and refuse from the individuals and the groups. If we go back to the second kitchen, we find that all the waste from both kitchens is pushed past the openings through which the food flows, into a large tube like a sewer pipe, through which it is carried out of the community. That disposes of all factory waste, but does not carry the individual and group refuse. From every family-like group there extends a small refuse pipe emptying into a main which carries it to several laboratories. Here all waste materials are sorted out; those that are useful are sent to be used in the community,

*Why No  
Waste  
is Wasted*



## How the Community Purifies its Breath



One of man's greatest problems has been how to supply pure air to buildings, and, in winter, how to warm them. This picture illustrates how perfectly nature solved the problem for man himself. The air we breathe through our noses is compelled to go through those crooked passages, so that it is not only warmed in winter, thus protecting the delicate tissues of the lungs, but the impurities in it are collected on the hairs that line these passages. When we breathe the air out it goes by a short, straight route because we need to get rid of it with as little delay and effort as possible. The insert picture in the lower left-hand corner shows what happens when we breathe through the mouth—the air comes straight in, carrying all its impurities directly into the lungs.

while the useless part passes from the community through special sewer pipes.

Can you imagine a community so perfectly ordered and so well served that no one need go out to select or to buy his food, but where one has only to draw his food from a pipe as we draw water at the hydrant?

Think of the simplicity of a whole community which is satisfied with practically the same food, served in exactly the same way, year in and year out!

You say, perhaps, that even if they need not go out to buy food, they must go to buy clothes! But no, these unique creatures "live in their skins," paying no attention to changing styles and fashions. They must, however, make their skins; so it keeps a good many groups of workers busy, winter and summer, making and keeping them in repair.

*Where the  
Fashions  
Never Change*

#### Wonders of the Capitol Building

You have noticed by this time that this community is exceptionally well governed and managed and that it is done quietly and without friction. Would you like to visit the office of the managers? These offices are situated in the capitol building—one of the busiest parts of the community.

To insure quick, instantaneous communication with any group of workers, a remarkable system of telegraphy has been devised. It is not quite like the Morse system, and yet it is the original telegraph system used long before Morse perfected his system.

The central telegraph station is the organ through which information is received and distributed by the government. As no one department

could attend to all the affairs of a community of more than a million members, there are various departments which specialize in certain fields of government. Each department, in addition to receiving and sending the messages pertaining to its field of work, must also make and keep records of all those transactions which are kept at the disposal of that or any other department.

*The Great  
Telegraph  
System*

Here in these offices is gathered together the most wonderful library of records known to mankind: records of sights and sounds; of tastes and smells; of touch and temperature. Records of the chemical tests made in the laboratories are all stored here. Messages which come in over the private wires are all classified and recorded. The specialists who analyze odors and tastes send the results to these head offices, where permanent records of these tests are made. The groups who have especial skill amounting to an actual sense for touch and temperature devote their lives to examining things through this sense and in tabulating the results.

*In the  
Great Hall  
of Records*

Those individuals who have an especially acute sense of sight form the Lookout Committee and spend their entire time in the lookout stations making observations, records of which are also kept in the library.

These principal departments of the government are the Bureau of Information, the Interpretation Bureau, the Executive Bureau and the Intelligence Bureau.

The experts who are delegated to the Information Bureau gather all kinds of knowledge. Not only do they study things within the community, but everything in the neigh-



borhood of the community. They have a perfect army of workers who are busy sending telegraphic and telephonic messages of unimportant as well as important matters; for the Information Bureau must be able to give help on a moment's notice on practically every subject. Even these expert and specialized workers sometimes fail to find a record at once. Workers are then detailed to look it up and report as soon as it is found. Occasionally a record cannot be found even after patient search, although it is there in its own particular pigeonhole.

## What Busy Offices!

The Interpretation Bureau does not collect data, but it brings together all the information already gathered upon any one subject, arranges and compares it, studies it singly and together and decides upon its worth, its power, its usefulness, its relation to other things, names it and classifies it and then places the result of its study on file at the disposal of higher departments which might at any moment have a call for such a name or such a valuation. Think how many telegraph messages pass between these two bureaus in the process of such work as this, in addition to all the messages sent from the lookout stations and the testing laboratories in collecting the information!

Still, after all this has been done, it remains for the Executive Department to send any messages regarding action. No community action, no group action, no individual action can be carried out without orders from this department or some one of its branches.

## The Substations and the Main Office

The head office of this bureau, as well as the head office of each of the other two bureaus, is situated in the capitol building, but on certain main lines of the community there are substations or relay stations.

At the executive relay stations the officials have power to act in minor cases without consulting the Bureau. They may not, however, act without advice upon any new case except where immediate danger is involved. New cases, "Hello! Central, What however simple, must go Shall We Do?" first to the head office to be considered in the light of the information and interpretation of similar or related cases. As there are no information records stored in the relay stations, these cases cannot be acted upon there. When the head office has decided upon a case and has repeatedly carried out a line of action, then the relay officers can always act in the same way without advice from the capitol.

In case of danger to the community, or to any part of it, from delay caused by sending word to headquarters and waiting for a reply, the relay station may send an emergency order for immediate action, followed by a special message to headquarters for advice as to further action.

This remarkable adjustment between superior and inferior officers of the executive department plays an important part in the safety and well-being of the community.

## Then Come the Commissions

These Bureaus are assisted by various commissions working under their supervision. Under the Executive Bureau are the Transportation Commission, the Food Commission and the Police Commission. All out-

going telegraph and telephone messages are delegated to a special commission under the Executive Bureau which manages also the Ventilation Commission and the Commission of Public Works, which includes the chemical works, milling works and sewerage system.

The Information Bureau manages the incoming telephone and telegraph messages and the Commissions on Sights, Sounds, Touch, Taste and Smell.

The Transportation Commission has charge of all distribution of food within the community, including the wonderful system of pipes leading from one factory to another, and the still more wonderful system through which the food in its finished form reaches the consumer.

The Food Commission has a fine corps of workers who manage the selection or rejection of foods offered at the mill, the grinding and liquefying of these foods and their chemical changes. This commission,

*Substations That Run Themselves* like some other parts of the Executive Bureau, is operated both from the head office and also from the relay stations. The Food Commission substations are automats; that is they are self-acting and need not wait for orders from the head office.

The food mill is placed so near to the capitol building that it is under the direct orders of the head office while all other matters relating to foods are managed by the relay stations with whose work the superior office never interferes.

The Telegraph Commission is also under both the superior and the inferior offices while the telephone system is managed by the head office alone.

I wish you could see all the won-

ders of the ventilation experts. This commission may not use the observatory nor the telephone system, but it has expert help from the scouts and testers as to odors in the air and as to its temperature and moisture.

*Exchanging Bad Air for Good* This commission manages the bringing in of air and its passage through the air pipes to the oxidation laboratory. It also runs the laboratory, provides a way for oxidizing the foods and for casting out impure air from the community and brings bad air from every individual back to the oxidation laboratory to be expelled from the community.

The supreme authority of the commune is vested in the Intelligence Bureau from which all new ideas come and to which one must apply if he wishes a reason for any line of action. This most logical body governs the intellectual life of the whole community.

A large number of the workers of the commune do very little if any thinking for themselves for they are so in the habit of depending upon the Intelligence Bureau to do their thinking for them. This may be one reason for the harmony which prevails in the community.

#### In the Great Picture Gallery

Would you like to look into the photograph gallery and see the experts take pictures? You have no doubt seen many cameras ranging in size from the little pocket kodak to the fine large camera of the city photographer, yet you never saw one so small nor yet so perfect as this one.

As you would expect, it is placed in the observation station and is operated by the Lookout Commis-



sion. One wonderful thing about the camera is its ability to photograph far and near objects; anything, in fact, from the stars in the sky to a fly on the table, by a simple

*The Most Wonderful of Cameras* adjustment of the focusing apparatus. Everything beyond twenty feet is in focus without adjustment. This camera is, in fact, a telescope and a stereoscope, as well as a camera. In each half of the stereoscope there is one hard lens and one liquid lens. It was only when this plan was copied that man succeeded in making a really good telescope.

Look out of the window. There is a rich green lawn upon which three little children are playing, their blue dresses and red sweaters making a gay spot in the foreground with the soft gray of a stucco house for a background. Now see the camera turned toward this same picture. A

*Color Photography Perfected* moment only and the photograph has been taken, perfect in every detail even to the exact colors which you noticed from the window. Nowhere else has color photography been so perfected. In these marvelous communities it has nevertheless been done for ages. As soon as the picture is taken it is sent to the Information Bureau which puts it in the hands of the Interpretation Bureau whose helpers store it in the library to be used by the Intelligence Bureau.

#### A Piano, a Telephone and Phonograph Combined

These communities have a wonderful telephone which they had perfected long before telephones were in use elsewhere. The receiver of this telephone is in the head office and communicates with the outside

world. All sounds—the human voice, the songs of birds, the rustle of leaves, the tinkle of bells, shouts for help, cries of distress, and every other imaginable sound,—are taken by the receiver and transmitted by the lines direct to the Information Bureau of the head office, thence to the Interpretation Bureau, thence to the library where the records are filed. These records are in a way similar to the records of a phonograph and may be brought out and repeated an hour, a week, or a year later. In some respects this sound-reproducing system may also be compared to a piano, as we shall see.

#### What a Pipe Organ!

It is one of the delights of the community to listen to the music of the pipe organ which is built in the capitol. This fine instrument has but two reeds, yet it is so adjusted that it *Only Two Reeds But Such an Organ!* plays difficult music in three octaves. It can reproduce songs with or without words and can talk better than any talking machine.

#### These Policemen Tend to Business

Someone has said that the average policeman is "a never present help in time of trouble." This witty saying, like many others, is more witty than true; for policemen, like firemen, are usually brave, devoted men. In the community we have been talking about *all* the policemen are brave and devoted—and as clever as they are brave. You might think such well behaved, orderly, busy individuals who have neither time nor desire to be unruly would therefore need no police.

As a matter of fact the members of the community itself never do anything unlawful nor disturb the

peace in any way. The trouble always comes from the outside. This perfect army of police is made necessary by the ease with which invaders may enter. No locks nor keys are used, no bolts nor bars and there is always some open door through which enemies may slip past the inspectors and the guards.

*No Locks  
But Many  
Policemen*

#### Attacks by the Enemy

The community has many enemies. These enter and make their home there and they multiply so rapidly that before the police have been notified or have discovered their presence, they have done some damage to the community. Sometimes they break the mill stones or put something into the acid of the laboratory which makes it too strong, then the whole action of the factory is disturbed. Sometimes they dull the lenses of the camera, injure the reeds of the organ or block the telegraph or telephone wires. When they become very strong they may even overcome the police and stop the operations of the pump.

*What  
These  
Enemies Do*

You see there really is great need for a competent police.

When a foreign body pushes itself into the community it is surrounded by the police, who, if they are strong and well nourished, push it out. When other enemies enter they are strangled one by one if possible, but sometimes they are too strong for the police.

When one part of the community is in the hands of the enemy, other members come to the rescue. Even desperate situations are often saved by these helpers, but sometimes the enemy is victorious and causes the death of the whole community.

#### Where This Marvelous Community Is

You have by this time guessed that this marvelous community is your own body but you may not have guessed that the individuals which make up the community are the millions of tiny cells that compose the body. In any event it will add to your interest to trace the activities of the cells, together with

*Did You  
Know You  
Are "It?"*

their relations to each other and to the body, for they are just such activities as have been described as taking place in the community. That the body is really a community of cells which specialize, each group in its own work, is a scientific fact. You will understand physiology better than ever before if we go back now and retrace the steps in the arrangement and management of this body community.

If the community described is your body, then the members of your family and your friends are some of the many other communities.

The opening into the mill is the mouth and the food which comes in is inspected by the eyes and tested by the taste and smell. These inspectors reject it if it is not up to the standard which they demand of the mill. The teeth are the grinding stones of the mill and the tongue is the group of muscular workers who throw the food from one side of the mill to the other. The salivary and maxillary glands are the chemical department of the mill which manufactures the saliva needed to change the starch foods to sugar. If the mill-stones (the teeth) are broken or wanting in places, the food is not properly ground up and it is hurried out of the mill before it has been properly mixed with saliva.

*What the  
Picture  
People Are*



## A MARVELOUS COMMUNITY

You can see for yourself how it hampers the work of the stomach which has neither saliva for starches nor stones for grinding, if the food comes in with the mill work only partially done. It is

*Take Good Care of That Little Mill!* therefore very important that the mill-stones be brushed once a day and be washed with clean water several times a day, and that the food should be thor-

other, an air-passage, leads to the lungs,—the community "oxidation laboratories." The lung-cells are the little rooms in which the air is stored to meet the tide of blood.

The passage leading to this laboratory is the trachea, at the opening of which is the larynx—"the pipe organ." The incoming air is always in position to play upon the reeds or cords of this "organ" of speech.

### A Peep Into the Pipe Organ



If you could see through the top of your own head, straight down to your vocal cords, while you are reading this aloud, you would see them as they are shown in the center picture. Notice how much closer they come together than in the first picture.

Those two strips at the side are called "false" cords. Although they look like vocal cords, they are not used in speaking.

The air coming up through the windpipe plays upon the edges of the cords much as you play upon the edge of a grass blade when you "make music" with it, holding it between your hands. Held loosely and blown upon softly, it makes a low coarse note; stretching it and blowing harder, makes the note higher and sharper, as you know.

When Mother sings baby to sleep the cords are stretched until they cover the center of the pipe, as you see in the third picture. She sings to the baby softly. If she sings high notes, she forces the air through the cords rapidly.

oughly chewed and mixed with saliva and not with cold water. Cold water should be taken when there is no food in the mouth and it will then be a help to the stomach. Water may be held in the mouth for three or more minutes after each meal to dissolve out from between the teeth any substances which might injure them.

### The "Oxidation Laboratories"

The throat is the central receiving room from which run the two passages which we noticed. One of the passages used solely for food goes direct to the stomach while the

There are many reeds in an ordinary church organ, while the human voice, with all its possibilities for song and speech, has but two cords. The trachea is not a solid tube, but, like every part and organ of the body, is composed of hundreds of cells. This long tube divides, sending one branch to each lung, and these branches divide and subdivide until they resemble the twigs of a tree.

Do you remember when we visited the oxidation laboratories that we saw the food pumped into the factory to be purified? That food was the turbid blood coming from

the right chamber of the heart—"the pump"—where the oxygen of the air mixed with the blood and clarified it, giving it the bright red color. Then it was sent back to the left side of the heart. This short circulation of the blood from the right side of the heart to the lungs, and back to the heart, is called the pulmonary or lung circulation. It is just a little trip the blood takes to get fresh air.

#### Following the Blood Through the Body

When the blood leaves the left side of the heart it is beginning its work of carrying liquid food through the arteries to every member of the body-community, to every cell. It starts on this journey by way of the big artery called the aorta which sends out smaller branches which divide again and again until the smallest group is reached. These groups take such nourishment as they need out of the blood and give back carbon dioxide and other waste materials. This blood-stream, now mixed with the "sewage" from the cells, can no longer flow in the arteries which carry only pure blood. It therefore enters the venous system by way of minute capillaries (hair-like tubes) which gather up the tide from all the cells and empty it into larger and larger pipes until it reaches the

large vein, the vena cava, which enters the right side of the heart. It is very clear now why the heart-pump must have two sides. There must be a way to keep the pure and impure blood separated. This impure blood then makes the pulmonary trip, leaves the sewage in the lungs to be breathed out, takes up

oxygen, and is ready once more to feed the hungry cells.

#### The Pure Food Delivery System

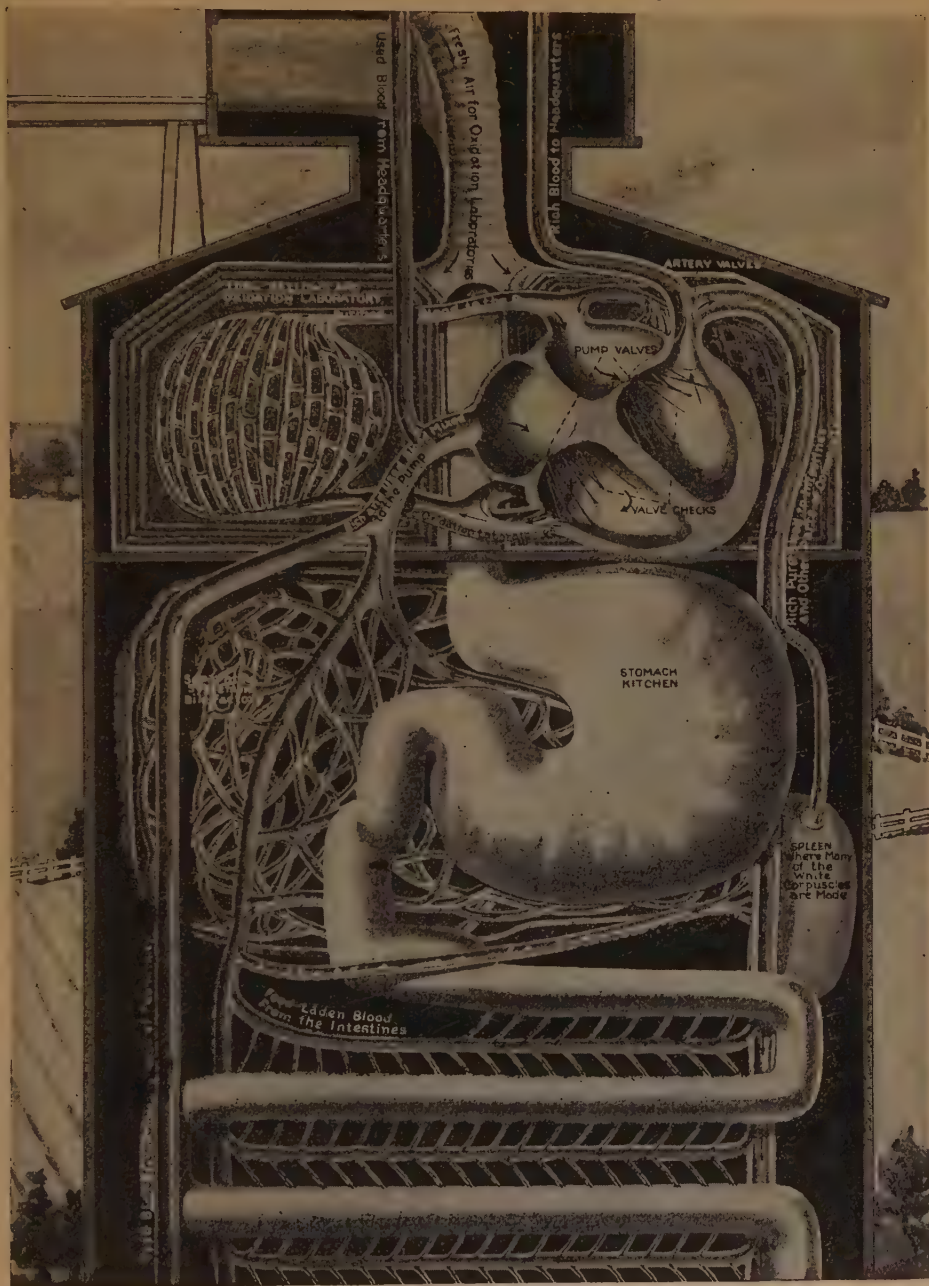
Just take a trip with your finger through the picture on the opposite page. Begin at the bottom. You notice that when it leaves the intestines the blood flows on through the tubes of the bile factory. There some of the blood is made into bile, some taken out as waste, and the rest is emptied, with used blood, into the right side of the town pump. (It's on the left side as you look at the picture). It then passes into the lower chamber. From there it is pumped to the lungs. The iron pigment in the blood attracts the oxygen of the air as a magnet attracts iron. The lungs are a network of thin walls and the oxygen is attracted right through them into the red corpuscles of the blood. Each corpuscle, like a car in a freight train, carries pigment and waste (carbon dioxide). As the corpuscles pass along they unload the carbon dioxide right through the wall; and back through the wall comes the oxygen and "gets aboard."

The red corpuscles, having unloaded their carbon and taken on oxygen, are now ready for the return trip. As they pass along the various tissues of the body the tissues help themselves to whatever food they need, together with a supply of oxygen. This oxygen is used to burn food for fuel to warm the body and to supply heat to the muscles for their work.

The muscles are like engines and they have to have heat to make them go, just as a steam engine does. Why do you run or slap your arms to get warm on a cold day? Because this exercise of the muscles generates



## The Pure Food Delivery System



We have headed this picture "The Pure Food Delivery System," because it shows just how the food of the community is purified and then delivered to the different members according to their needs.

Notice here that the community kitchen, called the stomach, is shown in its natural position. It would be necessary to turn the bottom of the kitchen up, as it is in the following picture, in order to see the pancreatic juice factory.

the extra heat they need to overcome the cold. And if you get *very* cold and don't do anything about it the muscles will just begin exercising themselves! That is to say, they shiver.

The reason for the word "circulation" is now explained. The blood circulates—makes the circuit from the heart—through the arteries to the venous capillaries and veins back to the heart with never a break in the circuit.

One reason why we should drink a plentiful supply of pure water is that water keeps the food in a liquid condition—thin enough to flow in a stream through the blood vessels. Another reason is that it keeps the tissues moist and the glands active. The chemical laboratories all depend upon water for their work.

#### A Pump That Works Itself

The wonderful pumping station—the heart—has been studied by thousands of scientific men for a long time but still nobody knows how it manages to make itself go. To be sure we know that the heart contracts and expands, and that this sends out the blood, but that does not explain how. The heart of the chick in the egg begins to beat a few hours after the mother hen first warms the egg, but how or why is the greatest mystery.

#### How the Town Pump Pumps

Don't look much like valentine hearts, do they—the first four pictures on the opposite page? But how about the last two? At the end of the stroke, you see, the lower part of the heart begins to come to a point, much like that of the conventionalized heart the artists put in

valentines. This change in the shape of the lower part of the heart is due to the fact that it is this part of the heart only that does the pumping. Notice how much thicker the lower part is than the upper. It needs this extra muscle to do its work. The partition wall is also made thick as it does part of the pumping. The right ventricle is shown larger and the partition thinner than they are in reality in order to give more space in which to show the action of the valves. In the picture on page 261 you will see the exact shape and thickness of the walls of the ventricles.

#### A Round Trip Every Fifteen Seconds

The heart sends the blood out with such force that it not only makes the circuit through all parts of the body, but comes back into the pump purified and ready to start over again all as a result of this strong outgoing stroke.

And how long do you suppose the blood takes to make this round trip! Fifteen seconds! Each pulsation sends the stream a little further, on through the body and on up and up until it pours in at the top of the heart again, thus keeping the blood going in its constant current and the veins and arteries always full.

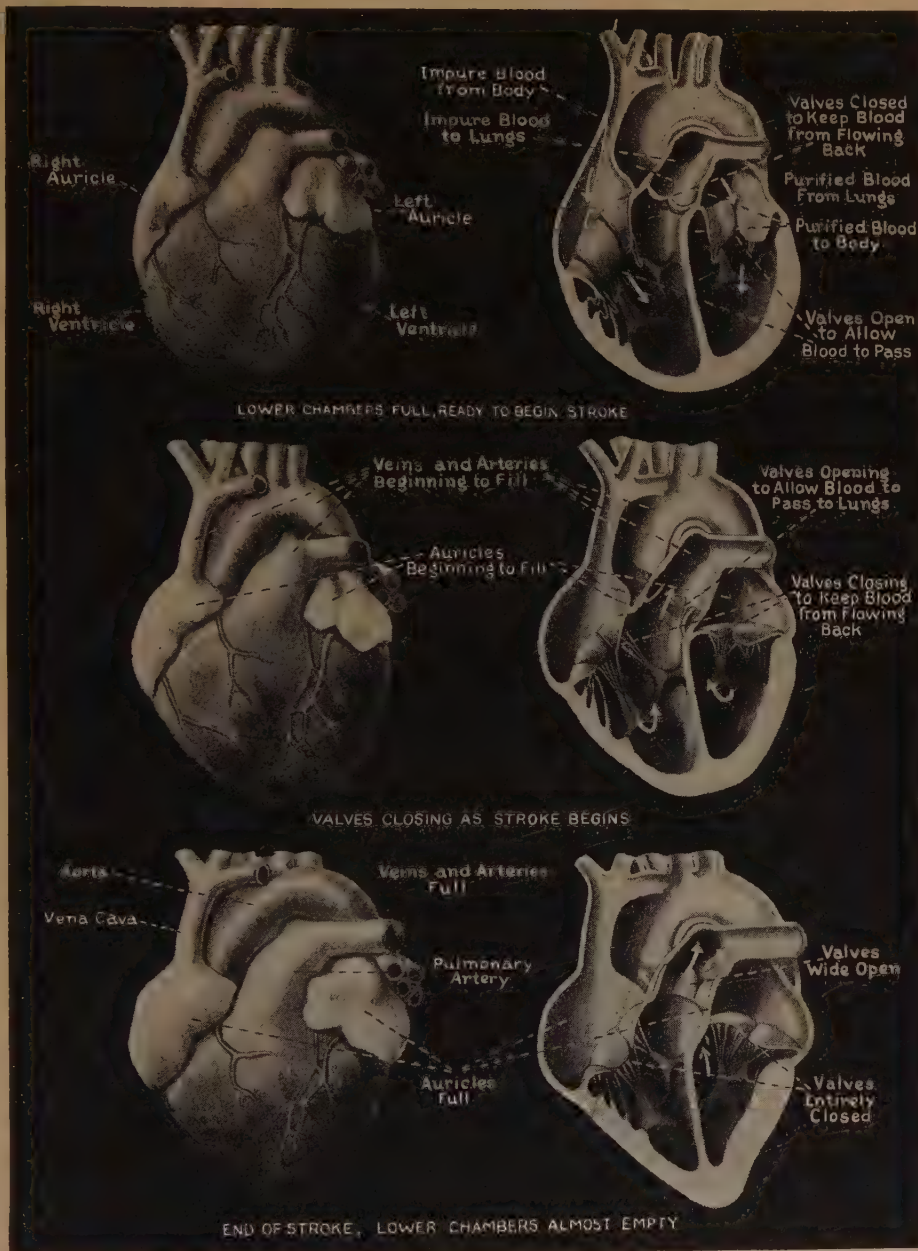
#### Why the Blood Doesn't Get Mixed Up

But how can the heart handle impure and pure blood at the same time without getting them all mixed up? It's on account of the valves and that partition that divides the heart into "rights and lefts." Notice how the valves open to let the blood pass into the heart on its way to the lungs when the heart expands, as in the first picture, and then how

*The Work  
of the  
Valves*



## How the Town Pump Pumps



These are pictures of the town pump—the heart—on a busy day. And it's always a busy day with the heart, as you know. No days off for the little town pump! Beat, beat, beat—pump, pump, pump—it goes night and day, day and night, all our lives. Do you know what happens to this busy, faithful little heart when a boy smokes cigarettes? It's as if he whipped it to make it go faster. The poison of the cigarettes paralyzes certain nerves which control the heart as a governor controls an engine. Then the heart goes to beating a great deal faster than it ought, and after awhile, if this keeps on, it breaks down entirely.

these valves shut as the heart contracts to pump the impure blood into the lungs and the pure blood through the arteries into the body.

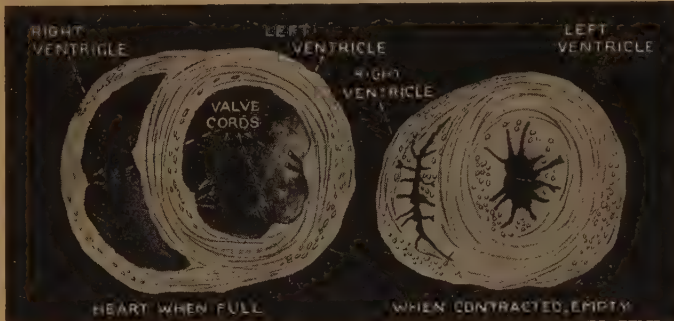
### How to Make a Heart Valve

Now, a little more about these valves. Punch a hole through a piece of paper with your lead pencil. Don't the little tongues hanging

how important it is that the air should be pure and contain the right amount of oxygen? When the air goes to the lungs to meet the blood and does not contain enough oxygen, it allows the blood to go circling back to the heart without having been properly purified. No wonder the head aches and the cheeks burn

*Don't Breathe Dirty Air*

### How the Pump Chambers Work



Here you are looking down on the heart from above, with the upper part lifted off. The picture shows the relative thickness of the walls, the shape of the ventricles, how they look when they are expanded to receive the incoming blood and when contracted to send it out.

Notice how the inside of the walls are folded or "puckered up" by the outgoing stroke. The little dots in the walls are the ends of the vertical muscles that pull the top and bottom of the heart slightly toward each other, while the horizontal muscles that surround the heart (shown by the curved lines) pull it together from the sides. It is the horizontal muscles that do the heaviest work.

down from the hole on the opposite side look like the open valves in the first two cross-section pictures? Press these paper tongues with your finger. They go back into place and fill up the hole. The heart valves work in the same way. The blood itself pushes open the door and comes in; then when the heart contracts the blood presses against these valves from the under side and keeps them closed. The little things under the valves that look like the ropes of a parachute, hold them from being forced back too far.

### Be Careful About Your Air

When you were in one of the oxidation laboratories did you notice

when one sits in an unventilated room filled with once or twice used air full of many peoples' waste carbon dioxide. That is just as dirty as the water in which several people have washed.

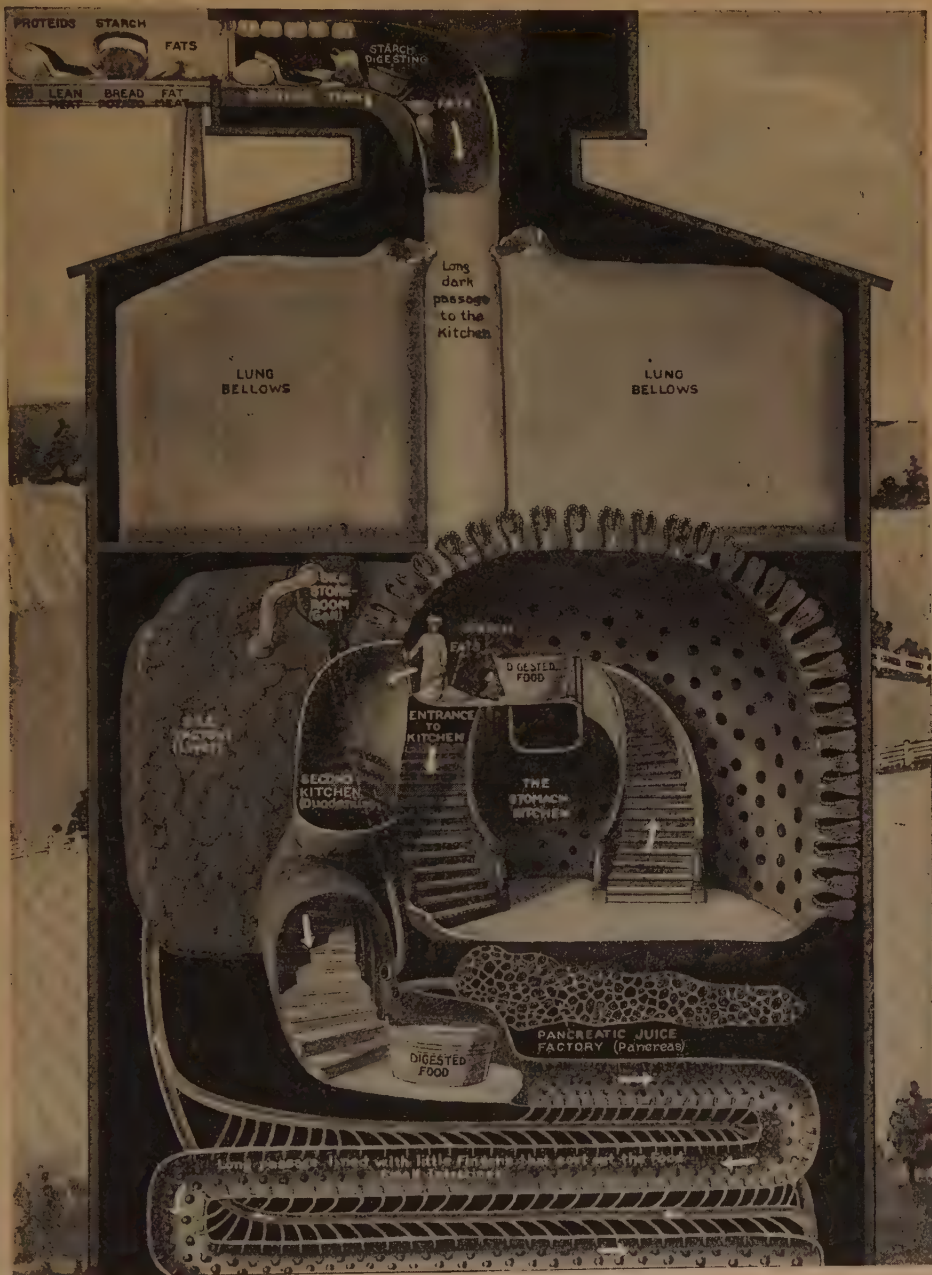
### Don't Overwork the Stomach Factory

Let us go back to the central receiving room, or throat, and instead

of leaving it by the air passage let us follow the food in its passage through the oesophagus into the stomach. The cells of the stomach lining create the gastric juice which acts upon proteins, such as lean meat, eggs, bread, gluten, cheese, etc., and besides that it tosses and churns the food for two hours or more until it is digested and mixed. If you have taken some water the work of the stomach is aided because the liquid mass mixes better than the pasty one which left the mouth. If the food has not been well ground up in the mouth the stomach has three times as much work to do as it ought to have. Some poor overworked stomachs have to do all



## A Trip Through the Food Factories



Here we are following some food through the community kitchens—an egg, a piece of lean meat, some starch, potato and a slice of bread. The egg and the meat are shown just as they come to the "mill," unground, although of course we grind everything that comes into the "mill." The digestion of foods of this kind does not begin in the mouth, but a large part of the bread and potato has begun to digest. The other food, after being acted upon in the first kitchen below, will be passed to the second kitchen, where the bile and pancreatic juice completes its digestion. As this food passes along that tube the little fingers in its walls sort out what the community can use, the waste going into the sewer.

the grinding that lazy boys and girls have neglected to do and then, instead of having mercy on the tired stomach, the ungrateful children

*"Oh, Do  
Give Me  
a Rest!"*

keep eating every little while so that the stomach has no time at all to

rest. It takes at least two hours to digest food and if one eats every two hours it keeps his stomach working constantly and keeps the chemical laboratories busy overtime, too. Simple foods are far better than rich ones and are digested in a shorter time.

### The Work in the Laboratories

After the food leaves the stomach and just as it enters the small intestine, it receives the juices from the "near-by laboratories"—the pancreas and liver. The pancreatic juice assisted by the bile from the liver makes very important changes in the food, which then passes along the small intestine.

The walls of the intestine have innumerable little finger-like things, called villi, protruding into the intestine tube. By the side of each villus is a gland that secretes the fluids, or chemicals, needed to change the starches, break down the sugars and digest the fats.

When this has been done, or while it is being done, the food passes along the long cylinder or tube, and soaks into the villi. These villi have porous walls through which the food passes into tiny tubes which meet other tubes and form larger and larger ones, until they enter the large portal vein, which carries it to the liver. From the liver it goes to the right side of the heart and then the circulation begins.

It is a curious fact that the fats do not go on this journey with the other foods, but go into tubes called lacteals, which empty into tubes going to the vena cava instead of to the liver.

What could be more wonderful than the way in which this stream of food is emptied into different tubes, and used in different ways?

### The Sewage System

The waste from this food mass (the waste from the stomach and intestine factories), together with the undigested food, is not taken up at all. Fancy those clever cells knowing enough to reject such things! All seeds and fruit skins; cellulose skins, seeds from vegetables, and connective tissue from meat with the undigested food pass by the villi, are not even noticed by the lacteals, are pushed further and further until they leave the small intestine and enter the large intestine, which is nothing more nor less than a big sewer pipe which carries this refuse out of the body.

There is another sewer system which carries off the personal waste of each cell or group of cells. As the cells—the community individuals—do their work, they wear out and die, forming uric acid. The blood, when it gives up its oxygen for the cells to use, takes back the carbon dioxide which they cannot use. These waste substances are taken up by the vein capillaries and emptied into the veins which carry it to the lungs and kidneys. These are the Sorting Stations of the community. The lungs sort out the carbon dioxide and expel it in breath through the bronchial tubes, the nose and the mouth.



The kidneys sort out the uric acid and send it through tubes to the bladder which holds it until it is full, then empties it into a special sewer pipe which carries it out of the body.

### The Brain and Its "Bureaus"

The story of the community government with its Bureaus and Commissions is so easily recognized as the brain and its functions that it needs little explanation.

All information which reaches the brain from outside the body must come to it through the senses, the messages being carried by the nerves of sight, touch, taste and smell which constitute the telegraph system, or by the nerves of hearing which constitute the telephone system. (You see by the diagram of brain and nerves that there are different parts or offices for different activities of the brain.)

The part of the brain which receives the information cannot pass judgment on it nor give orders as to its use. Those things are done by other parts of the forebrain which interpret and execute.

The records in the library are the memories of sights, sounds, smells, taste and touch.

Stop a minute to think how wonderful it is that your eyes take pictures more accurately than the best camera can do and takes them in color, too; that the brain makes a record of every one of those pictures so that you can think it back whenever you want to; that the ear catches sounds so delicate that the telephone could not transmit them and is able also to send a record of them to the brain for future reference.

*The  
Wonders of  
the Brain*

Now, as we shall see by a study of the picture on the opposite page, the ear itself may be compared to a piano in the way in which it responds to sound waves; or we may compare it to a telephone both in its response to sound waves and in the fact that these sound waves are carried to the brain over the "nerve wires."

### The Ear Piano and Its Piano-Player

How marvelously they are designed and put together, these ear pianos of ours! They would be wonderful enough if they really were made "giant size" only, and only giants had them, but isn't it the most wonderful thing of all that we ourselves have them, one in each ear, and they aren't any bigger than the end of your little finger?

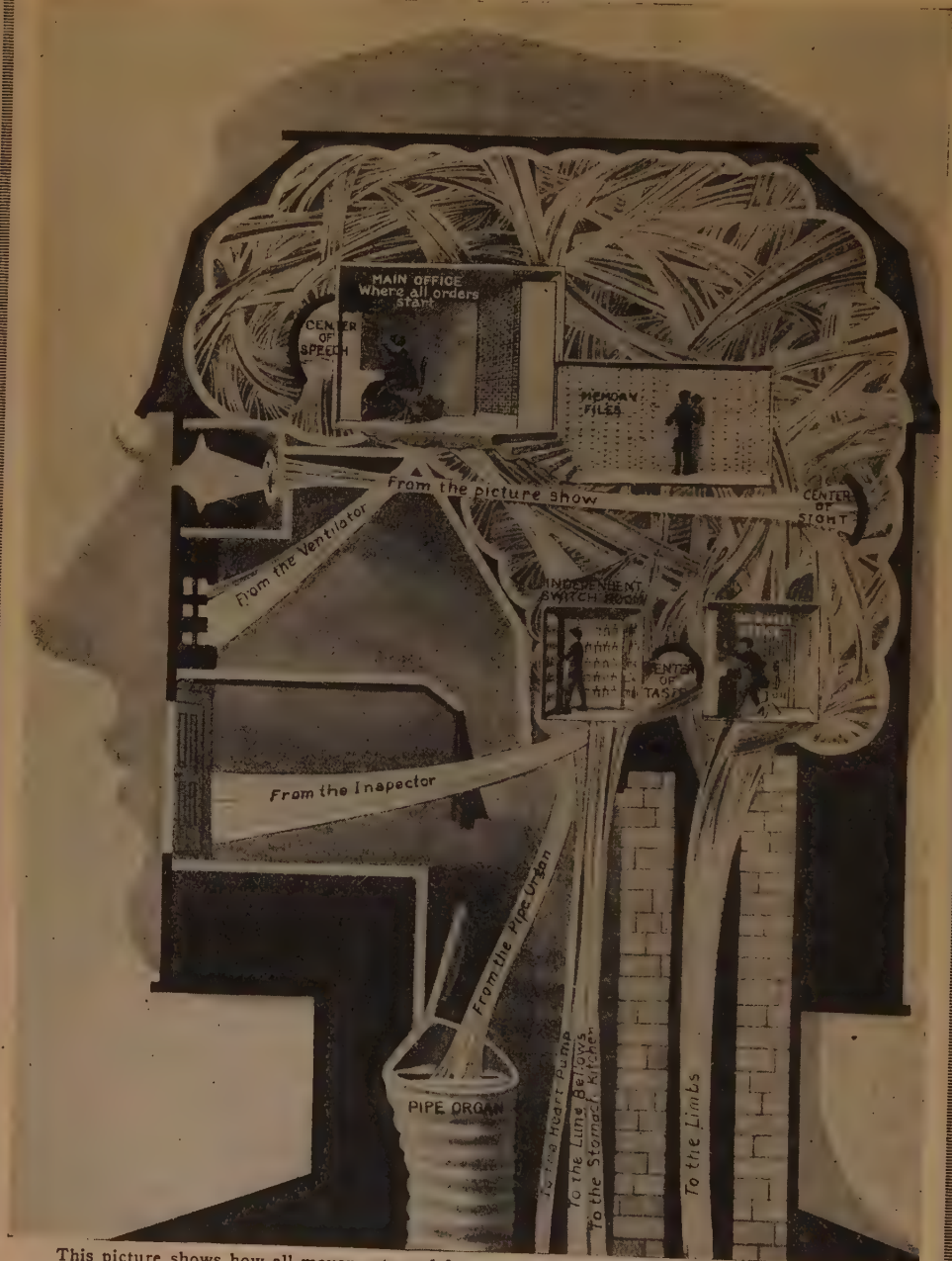
Think of it! Not only the thousands of strings packed away in that little winding shell, but the shell itself, the drum, the hammer, the anvil, the two fulcrums, and the stirrup, occupy a space in the ear not any larger than the last two joints of your little finger; not only taken care of in such a little space, but fitted together and with plenty of room in which to do their marvelous work. Hard to believe, isn't it? But there is no doubt about it. The structure of the human ear is one of the greatest wonders that the microscope reveals.

*Marvelous  
Little  
Machines*

### The Two Theories about Sound Transmission

Yet, with all the study and skill that have been applied to the cords in the little shell, learned men are not sure, in all respects, as to how they work. One theory, that of Helmholtz, the great German phil-

## A Look Into Headquarters



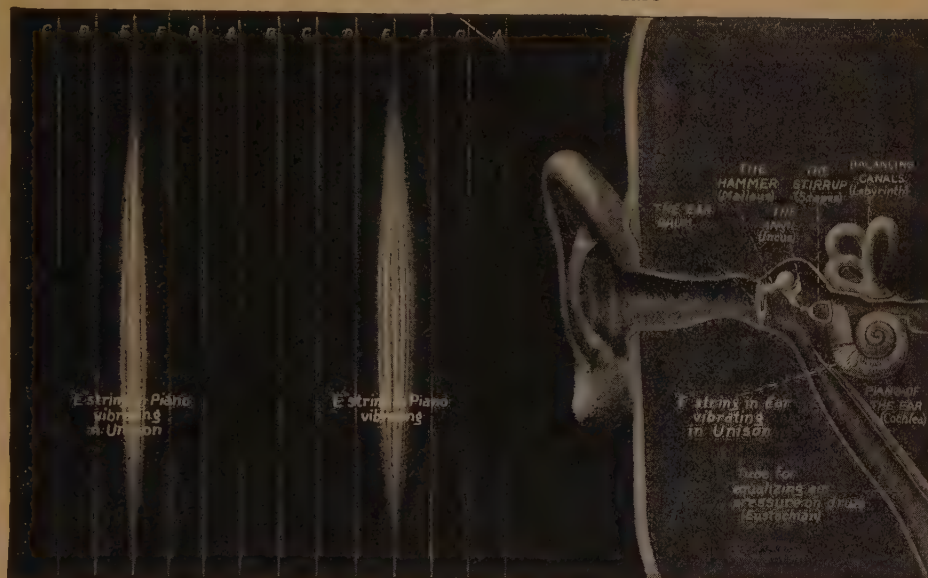
This picture shows how all movements and functions of the body are controlled from the head. All orders start from the main office. When we decide to go somewhere, for example, this part of the brain tells the legs to move. The order is passed on to the assistant, who sees to it that we go on walking until the "chief" tells us to stop. The figure in front of him looks after the work that goes on without our thinking—such as the beating of the heart—and actions that we can control somewhat, such as the motion of the lung bellows. You can easily find the memory files, the picture show, ventilator, and the "telegraph wires" that govern other parts of the body.



osopher and scientist, was that each of the cords reproduces a different sound, and it is this theory that we have illustrated. It is also known as the "harp theory." Another and later theory is that the cords, all be-

to a piano to make it play. You give this ear piano-player a tune and it begins playing it, the vibrations running like unseen fingers over thousands of little cords—down one music hall, up the other.

## The Little Pianos in Our Ears



Did you know that we have little pianos in our ears? They make music for us very much as do the strings of a piano. In the center of the picture you see the E string vibrating to make the note E. You notice the string on the left responds to this vibration because the two wires are tuned in unison. These same sound waves pass into the ear and set the "E string" in the ear to vibrating.

Notice there is a tube leading from the ear down into the mouth. The air in this tube, coming from the outside just as does the air that conveys the sound into the ear, has the same pressure and so makes the pressure on both sides of the drum equal and permits it to vibrate in such a way as to convey a "true report" of the sounds that strike it. If the air on either side of the drum exerted a greater pressure than that on the other, the drum would bend but would not vibrate so freely.

Do you know that if it weren't for those three little loops, called the labyrinth, you would fall down every time you stood up? The labyrinth is for the purpose of helping us to keep our balance. Those little loops are tubes filled with water, and as our bodies are inclined forward or backward or sidewise, the position of the water tells the brain which way we are tipping. It works very much on the principle of the spirit level used by carpenter.

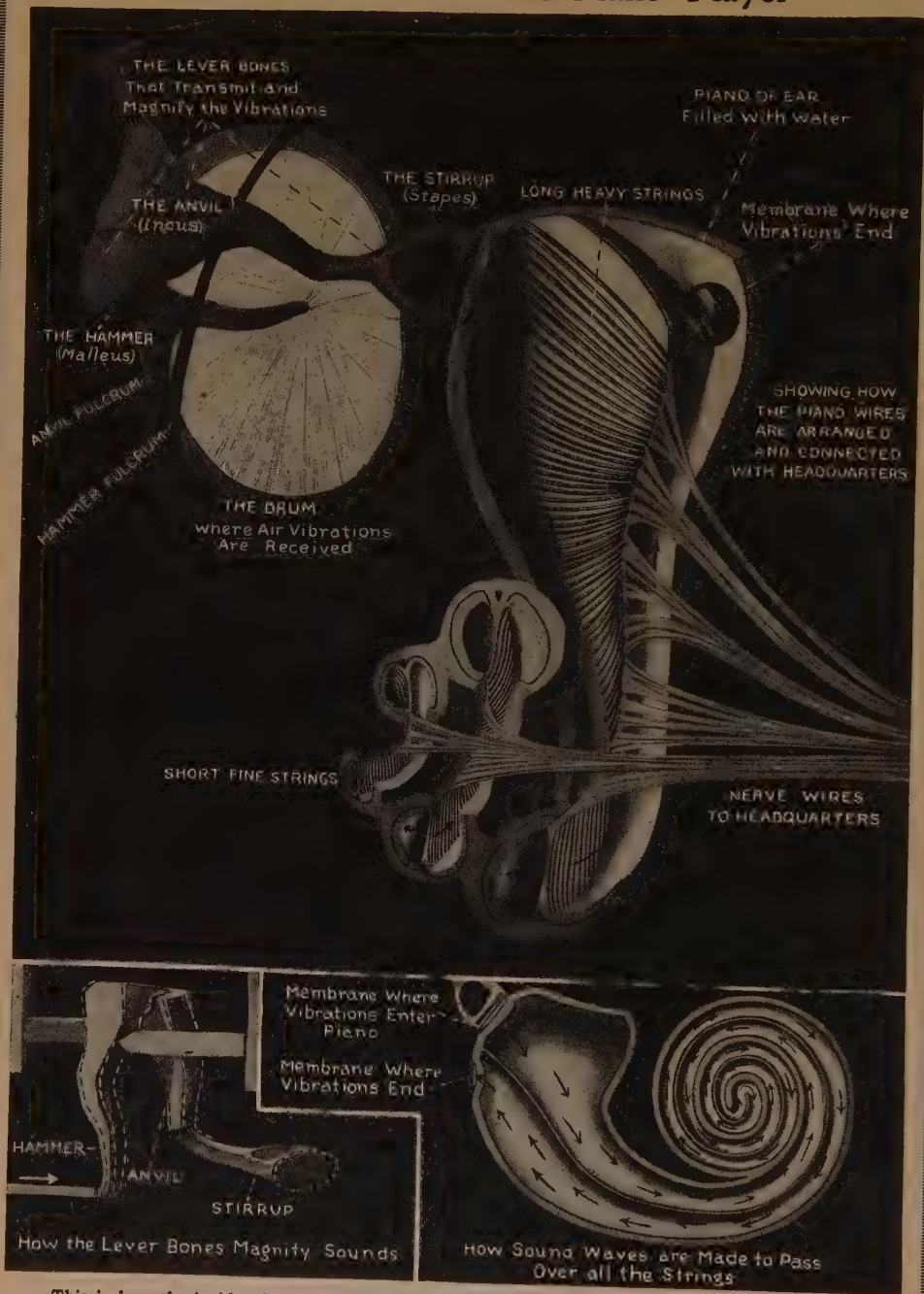
ing attached to each other, act as one membrane and carry sounds as does the diaphragm in a telephone or a Victrola.

## How the Piano Is Played

If we look at the cords from the piano standpoint then that part of the ear from the drum to the stirrup may be said to do the work of a piano-player—the kind you attach

The lower right-hand picture on the following page shows how the piano is divided into two compartments. These two compartments are filled with water, which carries the sound waves—in the direction shown by the arrows—down one hall and back through the other. But water doesn't give, you can't compress it as you can the air, so there is a membrane at the beginning of the

# The Ear Piano and Its Piano-Player



This is how the inside of your ear would look, if you had an ear as big as a giant's. It shows the inside of the ear piano with the "private wires" from each cord to the head offices in the brain where the information, music and other forms of sound, are received and acted upon by the executive staff for the instruction or amusement of the community.



first hall and at the end of the second. One membrane bulges out when the other bulges in, and bulges in when the other bulges out; otherwise the sound waves would not pass through the water—the water would just stand solid as it does in a full bottle when you try to drive the cork in further.

When a sound strikes the ear drum it sets it vibrating—shaking back and forth very fast. This sets the hammer going; but the ear hammer, instead of pounding on the anvil, swings it back and forth by that hinge. Then the anvil, fastened as you see by another hinge to the stirrup, makes the stirrup vibrate against the upper of the two membranes of the ear piano.

Each of the cords in the piano is of a different length, and as the sound waves travel through the water, each, according to one theory, finds the string of just the right length to vibrate for that sound.

The strings of a piano and the pipes of a pipe organ work in the same way—the shorter and smaller strings and pipes making the higher, finer notes and the longer strings and pipes the lower, coarser notes. In the ear the shorter strings vibrate rapidly in response to the more rapid vibrations of sound and the longer strings vibrate slowly in response to the slower vibration made by the coarser sounds.

#### How and Why Sound Beats Are Magnified

The lower left-hand picture shows how the hammer and anvil lever bones increase the force of sound vibrations so that they will be sure to set the cords going; or the diaphragm, if you take the newer

theory. You see, these levers are attached to each other at the top, and the anvil lever has a shorter arm than the hammer lever. The result is, as you will understand better when you study physics, that the arm of the anvil lever moves over a shorter space for a given vibration than the arm of the hammer lever and so causes a vibration to strike the inner membrane harder for a given sound than it does the ear drum itself. This is necessary because the water in the "piano" does not respond to vibrations as easily as the air.

#### Differences in the Art of Hearing

While all ears are made alike, of course, they differ greatly in their capacity for telling differences in sound. The sensitive, trained ear of the musician, for example, can tell fine shadings and differences in musical notes that the ordinary ear cannot distinguish at all.

And there is "sound deafness" as well as color blindness; there are certain sounds that some people either can't hear or can't make out among other sounds; just as there are certain colors which color-blind people can't tell from others. There are people, you know, who can't tell blue from green, and others to whom red looks the same as yellow.

#### The Insect's Private World of Sound

Do you know that insects, although their hearing machinery is very different from ours, can hear a whole world of sounds that the human ear can't hear at all? Some of them hear notes four octaves higher than the human ear can hear.

As the squirrel said to the mountain, "If I can't carry a forest on

my back, neither can you crack a nut!"

The cells which compose the police force are the white blood corpuscles. You have often heard of the red blood corpuscles which are like little boatloads of oxygen floating along in the food-stream of blood, but you have not heard so much of the white corpuscles. These white cells instead of uniting in groups as most of the cells do, float singly in the blood stream. This arrangement gives them a great advantage as police officers for each one can change his form to suit his need. When occasion requires, these corpuscles can make themselves so thin that they can push through the walls of the blood vessels and attack the disease germs which have entered the body.

#### The "Policemen" Make An Arrest

And how do you suppose one of these little policemen arrests a culprit? He simply swallows him!

*Swallowing Their Prisoners* That is, unless the guilty party is too large for him. In that case, he calls on other policemen—other white corpuscles and together they all manage to swallow him.

When one is in a healthy condition his blood contains a great number of these police-power corpuscles which eat up the disease germs as fast as they enter and one is almost immune from disease, but if the system is poorly nourished or run down nervously, the white corpuscles become few in number or weak in action and the person "comes down" with or "catches" something.

If a sliver or thorn finds its way into the flesh, the police cells surround it and die in their furious attack upon it; their dead bodies

form pus and the foreign body is pushed out. Then we say it "festered and came out." These policemen sacrificed their lives for the good of the body community.

The relay stations are a little more difficult to understand. Situated at intervals along the spinal cord, which runs from the brain to the end of the back bone, are groups of nerve cells which receive messages from different parts of the body and send them on to the brain; but after anything has been done many times it becomes unnecessary to send the message to the brain, for these relay stations can do it "automatically"; that is, we are not conscious of the ordering of the details of the operation. For example, we decide to go for a walk, start in the right direction and then think of something else while the steps are taken, automatically under the direction of the relay station. The big brain in the head, the executive office, has taught the little brains at these relay stations, how to walk, and now they can do it themselves, just as mother taught you how to dress yourself. Now you can do it and she doesn't need to take time from her other work to help you any more.

To be able to trust so many things like eating, walking and mechanical work to these relay stations relieves the mind greatly and leaves it free for other work.

#### Little Brains That Never Forget

You see, also, how very important it is not to do things that ought not to be done, or do right things a wrong way, for your relay stations will form habits that it will be hard for you to change.



## A MARVELOUS COMMUNITY

There is also another kind of relay stations which we spoke of in the community as automatic stations. These self-governing ganglia regulate the heart action, the lung and stomach activities and all other functions that we do not consciously govern. It would never do for a forgetful child or a busy man or woman to be responsible for every heart beat, every expansion of the lungs, every contraction of the stomach-wall. These important functions are trusted only to such nerve ganglia as can give their whole time and attention to that one thing and which have not the power to forget.

### How the Whole Community Moves

The mysterious nomadic life of the community and its remarkable way of moving off with all its mills, factories and telegraph systems is very simple now that you know you are yourself the community.

It would be very inconvenient if we had to leave any of these important things when we moved and quite as inconvenient if, like an old oyster, we could not move at all.

The trained cells of the leg muscles, bones, cords and ligaments form the army of expert movers. When you wish to go anywhere you "will" to do it, that is, you send an order from the executive office of

the brain over the telegraph wires or nerves, to tell the muscles to move your body. These movers (unless they are sick) are always ready to do your bidding. You know how quickly you can move your community to a ball game or a fire. It sometimes takes longer to move that same community toward a lawn mower or a broom. That is because in the first instance the community itself wishes to move, while in the second case it is impelled to move by the wish of some other stronger, or perhaps wiser community.

When you think of the skill it takes to originate a camera, or devise a telephone; to manufacture acids for a particular chemical; or the ability necessary to govern a city, you will appreciate the marvel of the human body in which groups of cells carry on all of these processes and many others. Here groups of cells specialize and become expert each in its own particular kind of work and are able to do their work better than man himself has ever been able to do it. Surely the author and creator of this marvelous community must have all knowledge, all wisdom and all power and whatever man does in mechanics and arts or in community life is but a feeble imitation of what has already been done in the human body.

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### EDITOR'S NOTE

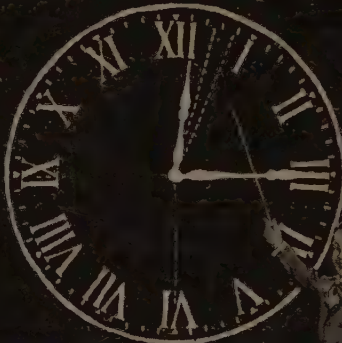
The illustrations form so important a part of this unique treatment of a difficult school subject that it is deemed proper to call attention to the fact that they were made under the direct supervision of Dr. Winfield Scott Hall, M. D. (Leipsic), Ph.D.; Professor of Physiology, Northwestern University Medical School; Dean of the Medical Faculty and author of a well-known series of school and college text books in Physiology.

# Practical Arithmetic and Business Helps

## THE STORY THE CLOCK TOLD

$$\frac{1}{4} = \frac{15}{60}$$

$$\frac{1}{2} = \frac{30}{60}$$



$$\frac{3}{4} = \frac{45}{60}$$

It Was All About Fractions and It Made Them Very Plain and Interesting to Johnny

THE Mathews children—Johnny, Grace and Polly—trooped into the dining-room for dinner. It was Wednesday noon and Johnny's mind was still a jumble of figures from the day's Arithmetic recitation at school.

"I can't understand those old fractions," he burst out, disgustedly.

"Why, the clock will tell you all about fractions," said Father, after filling up the plates all around.

"What time is it now?"

"Quarter past twelve," cried all of the children at once, for though the girls, who were older than Johnny, had left fractions behind them on the road of knowledge, they were still interested in the subject.

"What do you mean when you say a 'quarter'?"

"Why, I mean that the minute hand has gone one quarter of the way around the face," said Johnny after a moment's thought.

### The Clock's Picture of a "Quarter"

"It has taken the clock hands fifteen minutes to travel that distance, which is  $\frac{1}{4}$  of the clock's face. That space, when marked off by the minute hand, means

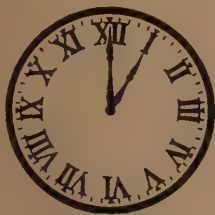
*How the Clock Slices Up the Fractions*  $\frac{1}{4}$  of an hour. When the minute hand gets to VI what part of the distance will it have traveled?

One-half of the clock's face or  $\frac{30}{60}$ , in terms of minutes, and when it gets to IX,  $\frac{45}{60}$ ."



"Oh, I see!" said Johnny. "One-fourth of the clock's face is the same as  $\frac{1}{4}$  of it,  $\frac{1}{4}$  as  $\frac{3}{4}$ ,  $\frac{1}{4}$  as  $\frac{1}{4}$ , and so on."

"Exactly," said his father. "The hands and the minute marks on the clock cut up big fractions into little fractions, just as Mother's knife cuts up the pie, doesn't it? Now, starting at twelve o'clock, what part of its journey around the clock's face has the hour hand traveled by one o'clock?"



## Then Johnny Tackled the Twelfths

Johnny thought a moment, then said, "Well, there are twelve of those spaces, like the one between XII and I, so it must have gone  $\frac{1}{12}$  of the distance."

"Right," said his father. "Now, what part of a day is that  $\frac{1}{12}$  that the hour hand travels?" Johnny started to say  $\frac{1}{12}$  of a day, then remembered that there are 24 hours in a day and that the 12 spaces on the clock's face represent one hour for the hour hand and five minutes for the minute hand. One hour was certainly  $\frac{1}{24}$  of a day, he thought, but how could  $\frac{1}{12}$  and  $\frac{1}{24}$  be the same. Then he remembered that the hour hand goes twice around the face of the clock between twelve o'clock this noon and noon tomorrow, so that  $\frac{1}{12}$  of the clock's face, when crossed by the hour hand, means  $\frac{1}{24}$  of a day because there are 2 12's in 24.

## But This One Stumped Him

His father next asked him what part of the whole day the distance between XII and I is, when traveled by the minute hand. That was a poser! Grace, the oldest of the children, thought she could explain it, and, with the aid of a pencil and paper, she did.

"That space represents five minutes, or  $\frac{5}{60}$  of the clock's face, doesn't it? But there are 12 5's in 60 so  $\frac{5}{60}$  of the clock's face is also  $\frac{1}{12}$  of it. The minute hand has to cross that space how many times in 24 hours? It goes all the way around once every hour, so in a day it would cross that space 24 times. Then, in making the  $\frac{1}{12}$  of one trip, it crosses 5 of the

Sister Grace  
to the  
Rescue

60 minute divisions—it makes  $\frac{5}{60}$  of its trip. But one whole trip of the minute hand is only  $\frac{1}{12}$  of the distance it travels in a day because it travels 24 times around the clock's face in 24 hours, and  $\frac{5}{60}$  of one trip is  $\frac{5}{60}$  of  $\frac{1}{12}$  of the distance it travels in a day. In Arithmetic picture language, that is  $\frac{5}{60} \times \frac{1}{12} = \frac{5}{720}$

of the distance it travels;  $\frac{5}{720}$  means that the minute hand has covered 5 of the 1440 spaces that it crosses in a day, but we can say that in a simpler way because there are 288 5's in 1440;  $\frac{5}{1440}$  of the distance traveled is also  $\frac{1}{288}$  of it, just as you said that  $\frac{1}{12}$  of the clock's face was  $\frac{1}{12}$  of it."

And then Johnny understood.

Taking out his watch, Father asked Johnny to count the minute divisions between XII and I. There were five of them of course. Moving the minute hand across three of the spaces, Father then asked Johnny how many more minute spaces the big hand had to go before covering the whole distance between XII and I. Two more, of course. "But each one of those spaces means  $\frac{5}{60}$  of the clock's face. Three of those sixtieths and two of them equal five-sixtieths or five of the minute spaces. Using Arithmetic language  $\frac{3}{60} + \frac{2}{60} = \frac{5}{60}$ ."

## Good Reasons for Those Rules

"Oh, now I see what teacher means when she says, 'In adding fractions, add the numerators, but do not add the denominators.' Three of the minute spaces and two of them make five in all, but it is  $\frac{5}{60}$  that they make, not  $\frac{5}{120}$ , because it is minute spaces we are talking about and they are sixtieths."

"Right again," Father said, "and here is another thing you must not forget. Suppose it took you a quarter of an hour to come home from school and three minutes to get your face washed for dinner. How many minutes in all?"

"Eighteen," cried Johnny at once.

"What did you do to get that answer?" asked Father. "You added one quarter of an hour and three minutes and got 18 minutes, or  $\frac{3}{10}$  of an hour."



## That "Common Denominator" Business

"Well, one quarter of an hour is 15 minutes, and 3 more minutes make 18," said Johnny. Then, "Oh, I see! I changed the quarter to minutes, and that's just like changing fractions to common denominators as we did in school today. Teach-

er says, 'Before adding or subtracting fractions, change them to a common denominator.'

"Yes, you cannot add minutes and hours and get minutes, any more than you can add knives and forks and get forks. You must change the quarter of an hour to minutes—change the  $\frac{1}{4}$  to sixtieths—because minutes or sixtieths of an hour is your common denominator."

This conversation between Johnny and his father had been so interesting that the others were almost through with their dinner by this time, while Johnny had hardly begun.

"Finish your dinner now, or you will be late for school,"

said Mother, as the dessert was brought in.

"Tomorrow's lesson is awfully hard," Johnny remarked, between mouthfuls. "It's something about inverting when you divide."

"That's easy," said Polly as she folded her napkin and whisked out of the dining-room.

"Tonight we'll see if the clock can't teach us something about that, too," said Father.

"I didn't know fractions would ever make me forget to eat my dinner," and Johnny set to work at subtracting from the remaining contents of his plate with astonishing rapidity.

### How the Clock Helped Invert the Divisor

That night the aid of the good-natured clock was again called in, to help in the business of inverting the divisor. The lesson dealt with the multiplication and division of fractions, and Johnny was puzzled to understand why his teacher had told them that when they divided  $\frac{3}{4}$  by 3, they must multiply it by  $\frac{1}{3}$ .

"Let's see," said Father. "When you say  $\frac{1}{12}$  of the clock's face, what does that 12 underneath the line mean? It means that you have taken one of the 12 five-minute spaces into which the face is divided, doesn't it? Now, if you multiply that 12 below the line by 5, what have you?"

"Sixtieths."

"And in doing that, what have you done to the clock's face? You have divided it up into smaller portions. Haven't you? Because  $\frac{1}{60}$  of it is a one-minute space, while  $\frac{1}{12}$  of it is a five-minute space. And do you see how that leads to the rule you do not understand? Mul-

tiplying the part of the fraction below the line—the denominator—divides the whole of which the fraction represents a part into still smaller portions. So when we want to divide a fraction, we multiply the part below the line.

$$\frac{1}{12} \div 5 = \frac{1}{12} \times \frac{1}{5} \text{ or } \frac{1}{60},$$

because  $\frac{1}{12}$  is the same as  $\frac{5}{60}$ —you learned that this noon—and when you take  $\frac{1}{5}$  of  $\frac{5}{60}$  you mean one of those sixtieths— $\frac{1}{60}$ ."

### Proving It by the Clock

"Let's prove it by the clock," Father went on. "The space between XII and I is  $\frac{1}{12}$  of the clock's face, but it is divided into 5 smaller spaces, and each one

of these represents a minute or  $\frac{1}{60}$  of an hour. If you take  $\frac{1}{5}$  of the space between XII and I you have one of the minute spaces, but that is  $\frac{1}{60}$  of an hour— $\frac{1}{60}$  of  $\frac{1}{12} = \frac{1}{60}$ ."

"Try some new numbers. You know that if you divide three-quarters of an hour by three you will have one quarter.

$$\frac{3}{4} \div 3 = \frac{1}{4}, \text{ or } \frac{3}{4} \times \frac{1}{3} = \frac{1}{4} \text{ or } \frac{1}{4}.$$

We multiply the denominator of that  $\frac{3}{4}$  by 3, because by doing that we will divide the clock's face into spaces  $\frac{1}{4}$  as large as the ones we started out with. But  $\frac{1}{12}$  of an hour is 3 five-minute parts, or 15 minutes, which is  $\frac{1}{4}$  of an hour. And this is the way we show that fact in Arithmetic language—

$$\frac{3}{4} \times \frac{1}{3} = \frac{1}{4}$$

We say the 3's *cancel*—the three above the line means that 3 of the parts are to be taken, and the 3 below the line means we are to divide the whole into 3's. To save time we just cross them out. It's like taking the same amount away from both sides of a balanced scale—the 3 above balances the 3 below the line. Take out both and you leave the fraction just as it was."

### How Fractions Act When You Multiply

"I see how you multiply denominators now, but what happens if you multiply the number above the line?" asked Johnny.

"Suppose we take 5 minutes which is  $\frac{1}{12}$  of the clock's face. Multiplying the numerator by 2 gives us  $\frac{2}{12}$ —

$$\frac{2}{12} \times \frac{1}{12} = \frac{2}{144}$$

But what is  $\frac{2}{12}$  of the clock's face? It is  $\frac{1}{6}$  of it—two of the five-minute spaces, or ten minutes, which is  $\frac{1}{6}$  of an hour. So how have we changed the value of the fraction, the  $\frac{1}{12}$ , by multiplying the numerator?"





"We have made it twice as big," answered Johnny. "When you multiply the numerator of a fraction you make the fraction bigger, but when you multiply the denominator you make the fraction smaller."

"Do you see why?" questioned his father.

"Yes, because the numerator just tells how many parts of the thing are taken,

but the denominator tells how big those parts are, and if there are only a few of

them they will be quite big, but if you keep multiplying and making more of them—that is, making the denominator a bigger number—you are cutting the parts up smaller and smaller all the time, so you are really dividing the whole into smaller pieces."



A FEW nights later the family was gathered around the library table after supper. Johnny's lessons for the next day were finished and he was busy mending one of the baby's toys. Grace was struggling with her Arithmetic lesson for the following day, and after chewing up two pencils and covering several sheets of paper with fruitless scribbling, she remarked dejectedly,

"Father, I wish you could find something that would help me understand decimals the way the clock helped Johnny with fractions. I think they are awfully hard and I'd like to know where they got the idea of figuring things by tens, anyway?"

"Just think," said Mother, looking up from her sewing, "and see if you can't answer that yourself. How do the little

*First Steps in the Number World*

folks in the 'baby grade' at school begin to count? Even you count that way yourself, sometimes, and have to be reminded that it is a good way to begin but a poor way after you have learned to think in figures."

Grace couldn't think what way Mother meant.

"Don't you remember how you first learned to count on your fingers? Savages, who are very much like little children, you know, learned to count first by counting on something, and what

could be more simple than counting on their fingers which they always carry around with them? And they were

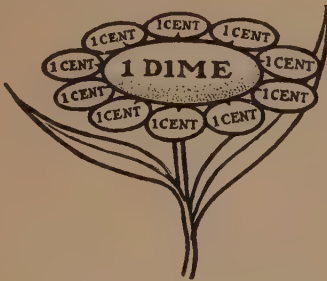


so accustomed to counting by tens, that when they came to invent systems of money and measuring they used ten as a unit. So today we have the metric measuring system and the money of most countries, as well as percentage,

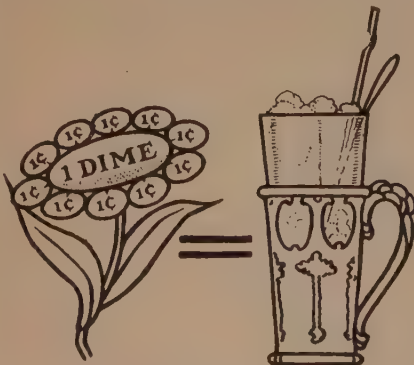
based on these ten decimals that are part of our hands."

"And was that how decimals began?" asked Grace. "If I had known that it would have been lots more fun."

"Now," Mother went on, "suppose we had black-eyed Susans in our garden that, instead of petals, had ten pennies arranged around their centers."



Grace loved flowers and had a little corner of the yard that was all her own. In it she had planted these very flowers Mother was talking about. "Then suppose we had cosmos blossoms that had



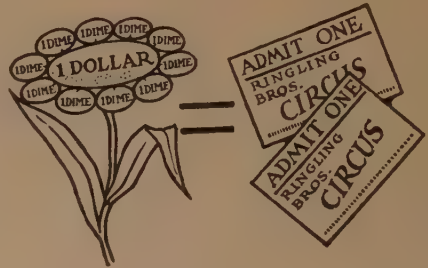
ten dimes for petals. And we might have big sunflowers with dollar petals. How many of the black-eyed Susans would you

have to pick before you could go down to the corner and buy an ice-cream soda?"

### Buying Sodas by Decimals

"Just one," answered Grace, "because sodas are ten cents."

"Or you could pull off one of the dime petals of the cosmos flowers, couldn't you? But suppose you and Polly wanted to go to the circus—that costs fifty cents apiece you know."



"I'd pick a whole cosmos because that would have ten dime petals, or I'd pick ten black-eyed Susans, because that would be a hundred pennies."



"Do you see?" said Mother. "It's all in tens. The pennies grow into dimes and the dimes into dollars. And it's the same with decimals, only in writing them, we leave off the naughts on the right-hand side, because we can do just

as well without them. You see how \$.10 is  $\frac{1}{10}$  of a dollar, and .10 or .1 is just another way of writing  $\frac{1}{10}$ —an easier way. But the black-eyed Susan penny petals are not worth so much and they have a different sign. It is .01. That naught between the '1' and the decimal point, making two decimal spaces, is just Arithmetic language for one cent or one hundredth. (*Centum*



is Latin for hundred, you know, and 'one cent' means one one-hundredth.)"

"I see that, Mama, but it's when you have two and three naughts that it bothers me so!"

## The Mills in the Decimals

"Well, suppose we had a rose, each one of whose petals meant one mill, or  $\frac{1}{1000}$  of a cent. How would we write its value in Arithmetic language?"

Grace did not know.

"A '1' to the right of the decimal point means what?" asked Mother. "If you have a naught after it, it is \$.10 or  $\frac{1}{10}$  of a dollar. But we don't really need the naught—the '1' and the decimal alone (.1) mean  $\frac{1}{10}$  too. And to say one cent or one one-hundredth, we put a naught between the '1' and the decimal point—.01. The second space means that we are talking about  $\frac{1}{10}$  of  $\frac{1}{10}$  or one one-hundredth of a dollar. But we want to write out one mill, which is  $\frac{1}{10}$  of one one-hundredth of a dollar.

"I think I know what to do," said Grace. "You keep on moving the 1's one place to the right when the numbers get smaller. That was in the lesson."

"That's right," said Mother. "We have .1 which means  $\frac{1}{10}$ . To take  $\frac{1}{10}$  of that we put in a naught and move the '1' over one space—.01.

Now to write  $\frac{1}{10}$  of that we do the same thing, put in another naught and move the '1' over farther—.001. You must remember that every naught to the right of the decimal point before you come to the figure, means divide by 10, but that you can add as many naughts as you want to the right of the figures, without changing the value of your decimal. This way—.01 means  $\frac{1}{10}$  of .1, and .1 means  $\frac{1}{10}$  of 1, but .010 is the same as .01, and .000 is the same as .0. But now that we have learned how to write the value of our one-mill rose petal, how many of them must there be on a rose before that rose is worth as much as one sunflower petal?"

Grace puckered her forehead in deep thought. Slowly she thought it out, aloud.

## How Decimals Help You Out

"There are ten mills in a cent, so the rose would have to have ten petals before it would be worth as much as the black-eyed

Susan petal. And it would have to have ten times ten, or a hundred petals, before it would be worth a whole

black-eyed Susan or a dime. And it would have to have ten times as many petals as that to be worth a dollar, or a sunflower petal;  $10 \times 10 \times 10$  (working it out) is 1,000."

"See how much work that took," said

Mother. "When if you would just remember that every space to the right of the decimal point means  $\frac{1}{10}$  of the one before it, you would know by just looking at .01 that you would put in a naught and move the '1' one space to the right to write  $\frac{1}{10}$  of it. Then you have three decimal spaces

*I-2-3*

—0 0 1, so that  $\frac{1}{10}$  of  $\frac{1}{10}$  of  $\frac{1}{10}$  of a dollar would be three spaces away from the decimal point—.001."

"I think I understand that, now," said Grace. "But I'll be sure to get mixed up when it comes to multiplying and dividing the old things."

## And Here Is a Multiplication Secret

"Let's see if we can't find a way out of that trouble, too," said Mother. "How would we draw three of the black-eyed Susan petals in Arithmetic pictures?"

"The black-eyed Susans have ten one-cent petals," began Grace.

"Let's call them one one-hundredths now," interrupted Mother.

"Three of them would look like this—.03," said Grace.

"And you would read the picture—?"

"Three one-hundredths."

"How would 35 of them look?" asked Mother.

".35—wrote Grace.

"Right, and how would 2 of the cosmos petals look?"

".2, of course.

"But how would 35 cosmos petals be written?"

Grace put down .35 and then saw that that was the same as 35 of the black-eyed Susan petals, which meant 35 hundredths. That wouldn't do because cosmos petals meant tenths, and 35 hundredths couldn't be written in the same way as 35 tenths.

"Thirty-five dimes are how many dollars?"

".35, of course.

"Thirty-five tenths, then, is 3 wholes and 5 over, or, in decimal language, 3.5—three and five tenths."

"Now how would you write 35 rose petals? Let's multiply it out."

"Thirty-five times one one-thousandth is thirty-five thousandths. The 'thousandths' tell you there must be three places there, and the 35 only uses up two of them, so we must put a naught after the decimal point."

.001

35

— .035

"Now suppose we were to multiply the thirty-five thousandths (.035) by the three-tenths (.3). What should we have? In fractions that would mean we were going to say  $\frac{35}{1000} \times \frac{3}{10}$ , which equals  $\frac{105}{10000}$ , doesn't it?"

But there is an easier way than that. To write  $\frac{1}{1000}$  decimally, how many spaces must you have to the right of the decimal point?"

"As many spaces as the number of times you have divided by ten," said Grace.

"Right," replied Mother, "and how many tens are there in 10,000?"

Grace began to count them on her fingers, then smiled as she remembered the connection between decimals and fingers.

"You have to divide by 10 four times to get ten-thousandths."

"There is an easy way to figure it out while you are multiplying," said Mother. "Count up the decimal spaces you have, all together, in that multiplication example,

$$\begin{array}{r} .035 \\ \times 3 \\ \hline \end{array}$$

and you find there are four.  $\frac{.0105}{.0105}$  Then put four of them in your answer."

"Why?" asked Grace.

"We're coming to that. A decimal is a fraction, isn't it?  $.5$  is just another way of writing  $\frac{5}{10}$  or  $\frac{1}{2}$ . The figures (the 35 in .035) tell you the numerator of your

*Fractions  
Related  
to Decimals*

decimal fraction and the number of spaces (three in the .035) tells you the denominator. Three spaces

mean thousandths; four, ten-thousandths, and so on. But the other night Johnny learned that multiplying the denominator, the part below the line, did what to the value of the fraction?"

"Made it smaller," piped Johnny from the other side of the table.

"All right; then when we multiply .035 by .3 we are multiplying thousandths by tenths, taking  $\frac{3}{10}$  of  $\frac{35}{1000}$ , so which will the decimal we'll get be, larger or smaller than the one we started with?"

"Smaller."

"And how do we make decimals smaller?"

"Oh, I see," said Grace. "By moving the figures farther to the right of the decimal point. And that's why you add up the spaces when you multiply—every space means you have divided by 10 once, and when you multiply three spaces by one space,

3 spaces      1 space  
 $(\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}) \times (\frac{1}{10})$  or  $.001 \times .1$ , it means you divided by 10 four times."

## Untangling the Division Puzzle

"That's right. And now let's see about those division examples. When you divide the denominators of fractions you remember the value of the fraction grows larger, so in dividing .035 by .07, you would increase the value of the decimal."

Grace wrinkled her forehead at this and her mother said:

"Put it this way: How many times do you have to multiply  $\frac{1}{1000}$  to make it  $\frac{1}{10000}$ ? You have to multiply the numerator by 5, don't you? And the denominator, 100, has to be multiplied by 10 before it becomes 1,000. So you must multiply  $\frac{1}{1000}$  by  $\frac{5}{10}$  to get  $\frac{1}{10000}$ .  $\frac{1}{1000} \times \frac{5}{10} = \frac{1}{10000}$ . Or  $.07 \times .5 = .035$ . So  $.035 \div .07 = .5$ . When we multiplied we added up all the spaces to find the number of spaces in the product, because spaces to the right of the decimal point mean divisions by 10, and our fraction was being made smaller—it was getting farther away from the decimal point. But in the division of decimals we subtract the number of spaces in the divisor from the number in the dividend and point off the quotient accordingly, because when you divide one decimal fraction by another one (the .035 by .07, for instance) you multiply its value by just as many tens as there are decimal spaces in the divisor. There are two spaces in .07, so you have multiplied the denominator of .035 by 10 twice when you divided it by .07. Let's see if that is not so.

$$\frac{1}{1000} \div \frac{7}{100} = \frac{1}{1000} \times \frac{100}{7} = \frac{1}{70}$$

You have changed the thousandths of the denominator,  $\frac{1}{1000}$ , to tenths,  $\frac{1}{10}$ , by multiplying by 100. But when we do that decimally, we know that every space in the divisor means multiply by 10 once, so we just subtract the number of spaces in the divisor from the number in the dividend."

"But what if your divisor has more spaces than your dividend? Like this example in tomorrow's lesson.  $.96 \div .0032$ ."

"You can tell at a glance that 32 goes 3 times in 96, can't you? So you know your answer will be 3 written somehow. In dividing .96 by .0032 you are multiplying by 10 how many times?"

"As many times as there are spaces to the right of the decimal point in the .0032," answered Grace. "So you are multiplying by  $10 \times 10 \times 10 \times 10$ , or four times."

"That's right, and so  $.96 \div .0032$  is 300—it takes two multiplications by 10 to make the dividend a whole number and the two more multiplications by 10 bring it up to hundreds. We can't subtract the number of spaces in .0032 from the number in .96, but we can add as many naughts as we want to to the right of the figures in our decimal, because they don't change its value a bit.  $\frac{.0032}{.9600} \overline{) 300}$ . So when the divisor has

more spaces than the dividend, you add naughts to the right of the dividend until it has as many spaces as the divisor, and your quotient is a whole or a mixed number."



## THE PERCENTAGE KEY POLLY FOUND IN THE PIE



IT was Saturday noon, and the Mathews family were eating luncheon. Grace's two playmates had been invited to remain. They had reached the dessert stage, and Polly, the oldest of the children, was helping her mother by cutting a delicious, big pie. The cook had made it extra large so that Polly could easily divide it into seven good-sized pieces and one half-sized piece for Johnny's second helping; for a second piece of pie, half as big as the first one, was regarded by Johnny as his by divine right.

*Johnny's  
Second  
Helping*

There was a lull in the conversation as Polly took up the pie knife, and she remarked, "There's been so much Arithmetic in the air here, lately, with Johnny and the clock and Grace and her flowers and things, that I don't like to say anything about my troubles, but I think Fractions and Decimals are easy compared to Percentage."

"Have you been having trouble with your Arithmetic, daughter?" asked Father, with a smile.

**"Percentage Before Pleasure," Said Mother!**

"Yes. Mother told me I must do my Monday's lessons before I go over to Louise's this afternoon, because she says you're going to take us all to the movies tonight and there won't be any other time to do them."

"Well, let's see what we can find to tell us about percentage," and Father looked thoughtfully over the table. "I believe the pie you are cutting will tell us all about it."

"How?" inquired Polly eagerly as she passed Mother the first piece.

*Percentage in the Pie* "Well, one per cent of a thing means  $\frac{1}{100}$  of it, doesn't it? If you divided your pie into five equal pieces what per cent of the whole would each one be?"

"Five per cent," answered Polly, without thinking.

### Why One-Fifth Is Not Five Per Cent

"No, now think. One-fifth of the whole pie would not be 5% of it because the whole pie is 100% and  $\frac{1}{5}$  of it is  $\frac{1}{5}$  of 100%, or how many per cent?"

"Oh, 20%, not 5%," said Polly. "Because there are 5 20's in 100. Then when I cut the pie into 5 equal pieces each piece is 20% of the whole pie."

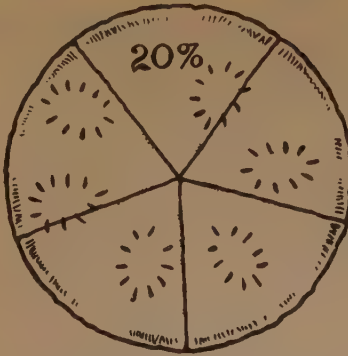
"Yes, and, if you cut it into 10 equal pieces each piece would be —?"

"10% of the whole."

"Into 4 equal pieces —?"

"25% of the whole."

All of this was plain sailing because Polly knew that  $\frac{1}{10}$  is .1, or .10 or 10%—that these are three ways of saying the same thing; that  $\frac{1}{4}$  is .25 or 25%, and so on. But the next step was harder.



### What Might Happen to Johnny

"If you had told Johnny he couldn't have his extra half piece this noon, and had cut the pie into 7 equal pieces, what per cent would each of us eat?"

But before Polly could think out her answer, Father asked another question.

"How do you change a fraction to a 'per cent,' so to speak?"

"You change it to a decimal fraction first and express it in hundredths, and that tells you what per cent of the whole it is."

"All right, if each of us ate  $\frac{1}{7}$  of the pie, what per cent would that be?" Pulling an old letter and a pencil from his pocket, Father gave them to Polly to use.

"To change a fraction to a decimal, you point off and add naughts to the numerator and divide it by the denominator," announced Polly, so this is what she put down:  $\frac{1}{7} = \frac{1.00}{7} = .14\frac{2}{7}$ . "One-seventh equals fourteen and two-sevenths hundredths."

"And  $.14\frac{2}{7}$  is what per cent of the pie?"

" $14\frac{2}{7}\%$ , because per cent means hundredths, and you must leave off the decimal point and call it per cent."

"Right. Now we've settled that question, suppose we find out how much of the pie



each of us really does eat, with that extra half piece of Johnny's taken out."

### Fractions and Percentage

Polly was puzzled, so Father suggested that she find out what part of the whole pie that half piece was.

"It's  $\frac{1}{14}$  of it because there are 7 other pieces twice as big as it is. That would make 14 other pieces like it, and it makes the 15th."

"That's right. And  $\frac{1}{14}$  of the pie is what per cent of it?"

By figuring it out on the envelope, Polly found that

$$\frac{1}{14} = \frac{1.00}{14} = \frac{1.00}{14} = .07\frac{1}{7} = 7\frac{1}{7}\%$$

"Now that we know that Johnny's extra piece of pie is  $7\frac{1}{7}\%$  of the whole, how much does each of us eat?"

### Percentage As Easy As Pie

"That piece is only half as big as the other pieces, because Mother says two whole pieces of pie are too much for anybody—even Johnny," said Polly, "so each of us must eat  $2 \times 7\frac{1}{7}\%$  of the pie, which is  $14\frac{2}{7}\%$ , or (because  $\frac{1}{7} = 1\frac{1}{7}\%$ )  $14\frac{2}{7}\%$  of the pie."

"Good," said Father. "Percentage by the





## PRACTICAL ARITHMETIC

pie method is 'as easy as pie,' isn't it?"

"And I know how much Johnny eats, too," cried Polly, still scribbling. "He eats one and one-half times as much as we do, or three times as much as his second piece.

$3 \times 6\frac{2}{3}\% = 18\frac{4}{6}\% = 20\% = \frac{1}{5}$   
 "Piggy, piggy, piggy, you ate a whole fifth of that great big pie," shouted Polly as Johnny disappeared through the dining-room door.

### Short Cuts In Arithmetic

Adding for combinations of figures:  
 We know at a glance the sums of the following:

|   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 3 | 5 | 6 | 7 | 4 | 2 | 3 | 8 | 4 | 6 |
| 5 | 3 | 5 | 4 | 3 | 4 | 2 | 3 | 7 | 4 | 6 |
| 4 | 5 |   |   |   |   | 2 | 3 | 4 |   |   |

|    |    |    |    |    |   |   |   |    |    |    |
|----|----|----|----|----|---|---|---|----|----|----|
| 10 | 10 | 15 | 10 | 10 | 8 | 8 | 9 | 15 | 12 | 12 |
|----|----|----|----|----|---|---|---|----|----|----|

When we see combinations of figures of this kind in columns which we are adding, we should add in the total of the combination and not each separate figure.

For example:

|       |
|-------|
| 5625  |
| 5485  |
| 6130  |
| 4430  |
| 3544  |
| 7243  |
| 363   |
| 1245  |
| 2365  |
| 36430 |

This should be added:

10 plus 10 plus 10 = 30. Put down 0 and carry 3. 3 plus 10 plus 10 plus 10 plus 10 = 43. Put down 3 and carry 4. 4 plus 10 plus 10 plus 10 = 34. Put down 4 and carry 3. 3 plus 3 plus 10 plus 10 plus 10 = 36. Put down 36.

#### Addition and Subtraction

When it is necessary to make many calculations in addition or subtraction, time may be saved by the omission of the line under the figures to be added or subtracted.

#### Multiplication

To multiply by figures when either or both of them end in a cipher or a series of ciphers, disregard all ciphers to the right of the other figures in the multiplier and multiplicand. After arriving at the product, add to it as many ciphers as were previously disregarded. For example:

|        |             |        |
|--------|-------------|--------|
| 2500   |             | 2500   |
| 270    |             | 270    |
| 175    | rather than | 175000 |
| 50     |             | 5000   |
| 675000 |             | 675000 |

To multiply by 25, 50, 75, etc.  
 Inasmuch as 25, =  $\frac{1}{4}$  of 100, 50 =  $\frac{1}{2}$  of 100 and 75 =  $\frac{3}{4}$  of 100, multiplication by

these numbers may be performed as follows:

25—Add two ciphers and divide by 4.

$$\begin{array}{r} 6250 \times 25 \\ 4 \overline{) 625000} \\ 156250 \end{array}$$

50—Add two ciphers and divide by 2.

$$\begin{array}{r} 6250 \times 50 \\ 2 \overline{) 625000} \\ 312500 \end{array}$$

75—Add two ciphers, multiply by 3 and divide by 4.

$$\begin{array}{r} 6250 \times 75 \\ 625000 \\ 3 \\ \hline 4 \overline{) 1875000} \\ 468750 \end{array}$$

#### Six Per Cent Method of Figuring Interest

For ordinary business calculations, a month is treated as 30 days and a year as 360 days.

Interest on \$1.00 for 1 year at 6% = \$0.06.

Interest on \$1.00 for 60 days ( $\frac{1}{6}$  of a year) at 6% = \$0.01, or  $\frac{1}{100}$  of the principal of \$1.00.

Therefore, to find the interest on any amount for 60 days at 6% divide by 100 (or point off two decimal places). For example: \$750.00 for 60 days at 6% = \$7.50.

To find the interest on any amount at 6% for more or less than 60 days, figure the interest for 60 days and then add or subtract as many sixtieths of this amount as the days are more or less than 60. For example: \$750.00 for 90 days at 6%.

$$\begin{array}{l} \$750.00 \text{ for 60 days at } 6\% = \$7.50 \\ 90 - 60 = 30. \frac{30}{60} \text{ or } \frac{1}{2} \text{ of } \$7.50 = \$3.75 \end{array}$$

$$\text{Answer } \$11.25$$

Or: \$750.00 for 45 days at 6%:

$$\begin{array}{l} \$750.00 \text{ for 60 days at } 6\% = \$7.50 \\ 60 - 45 = 15. \frac{15}{60} \text{ or } \frac{1}{4} \text{ of } \$7.50 = \$1.88 \end{array}$$

$$\text{Answer } \$5.62$$

To find the interest on any amount at any per cent for any length of time, find the interest at 6% for the length of time as above. Add or subtract from this amount as many sixths as the per cent is more or less than 6%. For example: \$750.00 for 90 days at 4%.

$$\begin{array}{l} \$750.00 \text{ for 90 days at } 6\% = \$11.25 \\ 6 - 4 = 2. \frac{2}{6} \text{ of } \$11.25 = \$3.75 \end{array}$$

$$\text{Answer } \$7.50$$

## Arithmetic and System in Business

You have often noticed the grocer's boy as he goes from house to house taking the day's orders. He stops at Mrs. Smith's. She orders a bottle of vanilla, three pounds of sugar, a pound of butter and a dozen eggs. He then goes to Mrs. Jones' house and takes an order for seven pounds of flour, a box of Uneeda Biscuits, an ounce of pepper and a box of matches. Mrs. Brown orders various other groceries; Mrs. Green orders still other things and so it goes as he makes his rounds.

If he did not stop as he took the order at each house to put it down on his pad or in his order book, he would not know when he returned to the store what each customer had ordered. The grocer would perhaps send Mrs. Jones seven pounds of flour, a basket of potatoes, a bottle of vanilla and an ounce of pepper, when she had ordered something entirely different. He cannot remember what each has ordered, so he puts them down.

### The First Step in Business

This "putting things down" is the first great step in business, in taking care of our money and providing for all the nice things money will buy and that money enables us to do for ourselves and for others.

An account book not only tells you what you have done with your money, but it tells you what all of us like to know—where more money is coming from; that is, who owes us money for things we have sold (if we are storekeepers, for example), or what we have done for them and what they owe us for doing it if we are doctors or lawyers.

Another thing—and this is the most wonderful thing about these account books—they turn pennies into dollars.

"Take care of the pennies," says the good old adage, "and the dollars will take care of themselves." It is in an account book that *Making Pennies into Dollars* you take care of the pennies; and then, the first thing you know there are the dollars, too!

An account book is just as important for men,—and so for boys—as law books are for lawyers or medical books for doctors.

An account book tells a boy how to think out money matters—just as a lawyer's books tell him how to think out a law case.

### Bookkeeping and Housekeeping

Yes, and girls, too. Whether she goes into business for herself, or learns to keep books for somebody else, or just stays in the great business of keeping house and making a home, a girl should know about account books. Every good housekeeper should also be a good bookkeeper. She should not only know just how much she owes the grocer and the baker and the butcher and dry goods merchant, but just how much she has to spend from week to week and how to spend it to best advantage. She can only do this best if she keeps an account of her income and her expenses.

Not only must we learn to put things down in our account book, but we must learn to put them down properly. If our grocer's boy, in taking the orders, were to put them down on whatever odd scraps of paper he happened to have with



him, when he returned to the store he would pull out of one pocket an old envelope on the back of which Mrs. Smith's and Mrs. Jones' orders would be jumbled together; out of another pocket, perhaps, a "movie" program on which would be scrawled the orders which Mrs. Brown and Mrs. Green had given him. The grocer would have difficulty in filling orders from such scraps of paper, consequently he takes care to provide the boy with a pad of paper or a book so that the orders may be recorded properly and clearly.

In keeping accounts, we must take care to use a book, and it should be one which will not easily become soiled and crumpled.

#### Don't Put Off Putting Things Down

Another point which is of importance to us is that we write down the things in the account book in the order in which they occur. If we receive \$1.00 on May 1, \$2.00 on May 2, 50c on May 3 and 75c on May 4, we should write them down in the above order and not May 4, 75c, May 2, \$2.00, May 1, \$1.00 and then May 3, 50c. If we mixed up all the dates, put the thirtieth of the month before the tenth and had May follow November, we should never know where to look for any one item and we could not tell, without difficulty, how much we had at any given time.

#### Where Blunders Cost Money

The final thing we should learn in keeping an account book is to keep it neatly. We may have put down everything in the right kind of a book in the proper order and yet if our writing runs up and down hill, if our columns of figures "wobble"

from side to side and the pages are covered with finger marks and ink spots, other persons will not think that we have kept the accounts well.

In addition to the matter of pride we should be careful in these respects because such things may lead us to make errors. The figure one, for example, if blotted, might look like the figure nine.

If we have now learned that in keeping an account book we must first be sure to put down everything we need to know about each item or transaction; that second, we must put it down when it happens or so soon after it happens that we will not have forgotten anything about it; that third, we must write it down in a book, a book which will not be easily torn, crumpled or soiled; that fourth, we must put things down in the order in which they occur; and fifth, that we must do our work neatly, we shall be good account keepers.

Every bookkeeper or keeper of accounts that learns well these rules is valuable to his or her employer. If we train ourselves carefully to do the above five things we shall be able to keep any account book, simple or complex, as soon as we become familiar with its form.

#### Different Kinds of Account Books

Various kinds of account books are used to keep track of various things. The grocer may keep an account book to show what things he sends to his customers each day, so that at the end of the week or at the end of the month he may send them a bill for all of the purchases. Or he may keep an account book to show the things he has bought for his store so that he may tell how

much he owes. The principal account book, however, which the small storekeeper uses or which we use for keeping track of our personal accounts, is a book in which to put down things we wish to remember about our money; how much we had; how much was given to us or earned by us; how much we have spent, and how much we have left. This we may call a Cash Book.

To keep a cash account we need to know only those things which we wish to remember about our money. We should first write down the amount of money we have when we start the account. As we receive money, we should put down properly, neatly and in an orderly manner the amount and what we received the money for. As we spend money, we should put down prop-

erly, neatly and in an orderly manner the amount and that for which we have spent it.

For a simple account, we may use a book the pages of which are ruled as below.

#### The "Rights and Lefts" in Bookkeeping

As a matter of convenience we use the left-hand page for the money we receive and the right-hand page for the money we spend.

On the first line at the top of the page we should tell what kind of things we are going to put on that page. For example, on the left-hand page, top line, we might put  
*The* "Cash Received during  
*Heading* the month of January"  
*of the Page* (or February or March, whatever month it happened to be).  
 On the right-hand side, top line, we





might put "Cash paid out during the month of January." This is called "heading up the page."

After heading up the page, we should state on the first line, under the heavy lines at the top of the page, the amount of money we have at the time we begin keeping the account. If we started the account January 1, we would put down on this line in columns 1 and 2, the date, as Jan. 1, 1916; in column 3, tell what it is, as "Cash on Hand"; in columns 4 and 5, the amount of money, the dollars going into column 4 and the cents into column 5.

As we receive money, we should write down the amounts on the left-hand page, putting the date in columns 1 and 2, telling from whom and why we received it in column 3 and the amount itself in columns 4 and 5, using, as before, column 4 for the dollars and column 5 for the cents. These amounts should be entered neatly in the order in which we receive them, using a line or more for each item.

If we follow these rules throughout the month we shall have made a record of every cent of money received and spent; we shall have written it in a proper book, in the order in which we received or spent it and our work will have been done neatly.

By adding up the left-hand page we are able to tell how much money we had at the beginning of the month, plus the money we received. By subtracting from this amount what we had at the beginning, we are able to tell how much we received. By adding the right-hand page we are able to tell how much we have spent. By subtracting the total of the right-hand page from the total of the left-hand page we are able to

tell how much money we should have in hand.

### Carrying Amounts Forward

When either the right-hand or the left-hand page is filled before the end of the month, we should add both the pages, write in the amounts and the words "Carried forward" and turn over the page. After writing in the headings on the new pages, we should enter on the first line under the heavy lines at the top of the page, in columns 1 and 2 the date; in column 3 "Brought forward;" and in columns 4 and 5 the totals of the pages we have just turned, the total from the left-hand page going to the new left-hand page and that from the right-hand page to the new right-hand page.

At any time we may add the left- and right-hand pages and subtracting the amount of the right-hand page (what we have spent) from the amount of the left-hand page (what we had at the beginning, plus what we have received) we are able to find what we should have on hand.

When we have reached the end of a month or of any other length of time that we may have decided to use, we should find the amount that we should have on hand and use it to start the next month or the next period of time. It should be entered on the left-hand page on the first line under the heavy lines at the top, using the columns as before.

### How John Jones Did It

On the next page we have a page from a book in which John Jones kept account of the money he received and spent. Under his father's guidance, John goes over the account each month, picks out the same

| CASH RECEIVED DURING JANUARY |     |    |                                      | CASH PAID DURING JANUARY |      |     |                                        |       |      |    |
|------------------------------|-----|----|--------------------------------------|--------------------------|------|-----|----------------------------------------|-------|------|----|
| 1916                         | Jan | 1  | Cash in hand                         |                          | 1916 | Jan | 3                                      | Candy |      | 05 |
| "                            | "   | 3  | Allowance from father                | 1 50                     | "    | 5   | New pair of skates                     | 1 25  |      |    |
| "                            | "   | 6  | Cleaning Mr. Jones' sidewalk with Ed | 25                       | "    | 7   | Candy                                  |       | 10   |    |
| "                            | "   | 10 | Allowance from father                | 10                       | "    | 10  | Treated Ed to Soda                     |       |      |    |
| "                            | "   | 12 | From Mrs. Jones for shovelling snow  | 25                       | "    | 12  | Musical Show at schoolhouse with Mabel |       | 25   |    |
| "                            | "   | 13 | From Mrs. Smith for shovelling snow  | 10                       | "    | 16  | Missionary Collection                  |       | 10   |    |
| "                            | "   | 17 | Allowance from father                | 15                       | "    | 20  | Candy                                  |       | 05   |    |
| "                            | "   | 24 | "                                    | 25                       | "    | 22  | "                                      |       | 05   |    |
| "                            | "   | 27 | For skates for mother                | 25                       | "    | 25  | "                                      |       | 05   |    |
| "                            | "   | 31 | Allowance from father                | 05                       | "    | 31  | Soda                                   | 1 97  |      |    |
|                              |     |    | Total                                | 25                       | "    | "   | Balance in hand                        | 1 18  |      |    |
|                              |     |    | Total \$3.15                         | 3 15                     |      |     |                                        |       | 3 15 |    |
|                              |     |    | In hand Jan. 1.50                    |                          |      |     |                                        |       |      |    |
|                              |     |    | Paid Jan. 1.65                       |                          |      |     |                                        |       |      |    |

kind of items and puts them together. He arranges January as follows:

Cash received:

Allowances from father..\$1.25  
For chores ..... .40

Total received. ....\$1.65

Cash spent:

Skates .....\$1.25  
Shows ..... .25  
Church ..... .10  
Candy ..... .22  
Soda ..... .15

Total spent .....\$1.97

By keeping this account book each month and each month going over it to put together the same kind of things, John will have at the end of the year a complete record of all the money he received and spent. This record might look something like the above.

This is a simple plan for keeping simple accounts, but if the principles laid down in the beginning are studied and if the method of separating the different kinds of items is understood, there should be no difficulty in keeping any book or books.

#### When You Have Money in the Bank

What would be the simplest way to keep a bank account? Would it not be to put down the amount of money we had in the bank at any date, add to it each amount we put in (deposit—as it is called) and deduct each amount that we withdraw? Such an account would look like this:

In bank, January 1.....\$512.63  
Deposited, January 2..... 100.00



## PRACTICAL ARITHMETIC

In bank, January 2.....\$612.63  
 Deposited, January 10..... 150.00

In bank, January 10.....\$762.63  
 Withdrew, January 11..... 102.50

In bank, January 11.....\$660.13  
 Deposited, January 16..... 250.00

In bank, January 16.....\$910.13  
 Withdrew, January 31..... 432.13

In bank, January 31.....\$478.00

If we keep account in this way of our deposits and our withdrawals, we should always be able to tell the amount of money we have in the bank. Suppose, however, we wish to know how much money we deposited during January, or how much we withdrew. We are able to tell this only by separating the amounts of money we put in and took out. For example:

### Deposits

January 2.....\$100.00  
 January 10..... 150.00  
 January 16..... 250.00

Total deposits.....\$500.00

### Withdrawals

January 11.....\$102.50  
 January 31..... 432.13

Total withdrawals.....\$534.63

It is a simple matter to do this in the example given, but if we had a deposit every day and if we withdrew hundreds of items, it would be a long, difficult task to find out how much we deposited and how much we withdrew.

### But This Is a Better Way

We must find a better way of keeping our bank account.

Instead of putting down the amounts, one under the other and adding or subtracting as we did before, let us put down the balance on hand and the deposits on one side, and the withdrawals on the other side. Our account would then look like this:

In bank, January 1.....\$512.63  
 Deposited, January 2..... 100.00  
 Deposited, January 10..... 150.00  
 Deposited, January 16..... 250.00

In bank plus deposits..\$1,012.63  
 Withdrew, January 11.....\$102.50  
 Withdrew, January 31..... 432.13

Total withdrawals.....\$534.63

By subtracting the total of the right-hand column from the total of the left-hand column:

\$1,012.63  
 534.63

\$ 478.00

we are able to tell how much we had in the bank January 31. By subtracting the amount of money in the bank January 1 from the total of the left-hand column:

(Total of left-hand column \$1,012.63  
 In bank, January 1..... 512.63

Deposits during January \$500.00) we are able to tell with little trouble the total amount of money we deposited during January. We can also tell at a glance from the right-hand column how much money we have withdrawn.

If we kept a cash book, deposited in the bank all of the cash we received and either drew money from the bank to make each payment or else made the payment by check (which is an order on the bank to pay the amount), the cash book would also be a record of the bank

PICTURED KNOWLEDGE

Many concerns use their cash book in this way to keep track of the bank account. If, however, we do not deposit in the bank all of the cash we receive just as we receive it, we cannot use this plan. We may instead keep the account in a "check book." This "check book" is a book containing blank checks which the

In some large concerns where it is not convenient for the bookkeeper to have the check book, both of the methods are used, that the bookkeeper and the person who has charge of the check book may each know all of the facts concerning the bank account.

## CASH RECEIVED

|                | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG  | SEPT | OCT | NOV | DEC | TOTAL |
|----------------|-----|-----|-----|-----|-----|------|------|------|------|-----|-----|-----|-------|
| allowance from |     |     |     |     |     |      |      |      |      |     |     |     |       |
| father         | 125 | 1 - | 1 - | 1 - | 125 | 1 -  | 125  | 1 -  | 1 -  | 125 | 1 - | 1 - | 13 -  |
| Expts from     |     |     |     |     |     |      |      |      |      |     |     |     |       |
| Uncle John     |     |     |     | 5 - |     |      |      |      |      |     |     | 2 - | 7 -   |
| Five Choles    | 40  | 20  | 30  | 10  | 20  | -    | -    | -    | 40   | 50  | 10  | -   | 240   |
| Work during    |     |     |     |     |     |      |      |      |      |     |     |     |       |
| summer in Mr   |     |     |     |     |     |      |      |      |      |     |     |     |       |
| Jones' office  |     |     |     |     |     |      | 15 - | 12 - | 3 -  |     |     |     | 30 -  |
|                |     |     |     |     |     |      |      |      |      |     |     |     |       |
|                |     |     |     |     |     |      |      |      |      |     |     |     |       |
|                |     |     |     |     |     |      |      |      |      |     |     |     |       |
|                |     |     |     |     |     |      |      |      |      |     |     |     |       |
| TOTAL          | 165 | 120 | 150 | 610 | 140 | 1 -  | 1625 | 13 - | 440  | 175 | 110 | 3 - | 5240  |

CASH SPENT

|                    | JAN  | FEB | MAR  | APR | MAY | JUNE | JULY | AUG  | SEPT | OCT | NOV  | DEC  | TOTAL |
|--------------------|------|-----|------|-----|-----|------|------|------|------|-----|------|------|-------|
| Skates             | 1.25 |     |      |     |     |      |      |      |      |     |      |      | 1 25  |
| Shows              | 2.5  | 60  | 25   | 10  |     |      | 40   |      |      |     | 25   |      | 1 85  |
| Sunday School      | 10   | 10  | 20   | 20  | 25  |      | 35   |      |      |     | 20   | 30   | 1 70  |
| Candy              | 2.2  | 20  | 15   | 50  | 10  | 10   |      | 15   | 15   | 25  | 30   | 10   | 2 22  |
| Sodas              | 15   |     | 10   |     | 20  | 10   |      | 30   | 20   | 25  | 10   |      | 1 40  |
| Baseball games     |      |     |      |     |     | 50   | 1 -  | 1 -  | 25   |     |      |      | 2 25  |
| Baseball           |      |     |      |     |     | 75   |      |      |      |     |      |      | 75    |
| Glove              |      |     |      |     |     | 1 25 |      |      |      |     |      |      | 1 25  |
| Bathing suit       |      |     |      |     |     |      | 1 00 |      |      |     |      |      | 1 -   |
| Spent on vacation  |      |     |      |     |     |      |      |      | 4 50 |     |      |      | 4 50  |
| Gum and books      |      |     |      |     |     |      |      |      |      |     |      |      | 1 -   |
| Birthday presents  |      |     | 1 -  |     |     |      | 1 -  |      | 50   |     |      | 50   | 3 -   |
| Christmas presents |      |     |      |     |     |      |      |      |      |     |      | 3 -  | 3 -   |
|                    |      |     |      |     |     |      |      |      |      |     |      |      |       |
|                    | 1 97 | 90  | 1 70 | 80  | 55  | 2 70 | 3 75 | 1 45 | 5 60 | 50  | 1 85 | 3 90 | 25 67 |



## The Book That Draws the Money

The pages of the check book provided by the bank are usually made up of three or four checks each with a "stub," with perforations between the checks and between the checks and the stubs, as you see in the following illustration:

put down in the column at the right of the stub. The amounts of the checks are added as we go along.

When we have used a page of checks we carry forward the total sum of the checks on that page to the top of the column on the stubs on the next page and add it in with

|      |       |
|------|-------|
| STUB | CHECK |
| STUB | CHECK |
| STUB | CHECK |

The purpose of the stub is that we may put down on it the name of the person to whom we gave the check, why we gave it to him and the amount. After the check is made and torn out, the stub remains in the book. The amount of the check is

the amounts of the checks on that page.

In this way we shall have done what we did before in our cash book illustration. We shall have put down by themselves all of the amounts which we have withdrawn and added them, so that we may be able to tell

at any time how much money we have withdrawn from the bank, although instead of using one page on which to put the amounts, we may have used many pages.

On the back of the stubs in the check book there are printed two columns and in these we may keep a record of the deposits we make in the bank.

If we were keeping the record in our check book, it would appear on the back of the first stub, as follows:

|                                         |          |
|-----------------------------------------|----------|
| Balance, January 1, 1916                | \$512.63 |
| Jan. 2 Cash rec'd from Thomas Smith..   | 100.00   |
| Jan. 10 Cash rec'd from William Jones.. | 150.00   |
| Jan. 16 Cash rec'd from Theodore Brown  | 250.00   |

Total ..... \$1,012.63

The addition of these figures is of course the total of what we had at the beginning plus what we have added to it. This total, less what we had at the beginning, will give the amount we have deposited.

By subtracting the total of the checks from the total shown on the back of the stubs, we can tell how much money we should have at the bank.

At certain times in the year, perhaps once a month or once in three months, the bank tells us how much we have on deposit according to its records and at the same time returns to us the checks it has paid out of our account.

Comparing the amount which the bank tells us it has in our account with the amount which our record shows, we may find, and usually do find, that the amounts do not agree. The amount shown by the bank will generally be the larger.

To find the reason for the differ-

ence in the two amounts, we must take the checks which the bank has paid and returned to us and compare

*The Secret  
of the  
Difference*

them with the stubs in our check book to see if every check we have sent out has been paid by the bank and returned. The bank only knows that we have given out checks when it is asked by the person who holds them, to pay the checks. For instance it may happen that we have made out and mailed a check to a person on January 31, which this person does not get until February 1 or 2 and which is not brought to the bank until February 3 or 4. If the bank were to tell us the amount which we have on deposit January 31, it would not have paid this check at that time and consequently the amount which the bank tells us is on deposit would be greater than the amount which our book shows by just the amount of this check.

For example, let us suppose that the bank tells us on January 31 that, according to its books, we have \$760.13 on deposit and it returns to us the checks it has paid.

As our check book shows that we have only \$478.00 in the bank, we compare the checks which the bank returned to us with the stubs of the checks in our check book and find that the bank has not as yet paid and returned to us the check which we sent to Mr. John Doe, January 31.

We therefore put down the amount which the bank tells us it has in our account .... \$760.13 subtract the amount of the check which we have given to Mr. John Doe but which the bank has not yet paid... 282.13

and the result is that which our record on the



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |       |  |  |  |  |  |  |  |  |  |  |                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------|--|--|--|--|--|--|--|--|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No. _____ \$ _____<br>To _____ 191____<br>For _____<br><table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center;">DOLLARS</td> <td style="width: 50%; text-align: center;">CENTS</td> </tr> <tr> <td style="height: 20px;"> </td> <td style="height: 20px;"> </td> </tr> <tr> <td style="height: 20px;"> </td> <td style="height: 20px;"> </td> </tr> <tr> <td style="height: 20px;"> </td> <td style="height: 20px;"> </td> </tr> <tr> <td style="height: 20px;"> </td> <td style="height: 20px;"> </td> </tr> <tr> <td style="height: 20px;"> </td> <td style="height: 20px;"> </td> </tr> </table> | DOLLARS | CENTS |  |  |  |  |  |  |  |  |  |  | <br><b>Glencoe State Bank</b> 70-1319<br>Glencoe, Ill. (2) 191____ No. (1)____<br>COOK CO.<br>Pay to the order of (3) _____ \$ (5)____<br>_____ (4) _____ Dollars<br>_____ (6) _____ |
| DOLLARS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | CENTS   |       |  |  |  |  |  |  |  |  |  |  |                                                                                                                                                                                      |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |         |       |  |  |  |  |  |  |  |  |  |  |                                                                                                                                                                                      |

NOTICE: Make no Alteration or Change On Any Check  
 If Written In Ink With New Check

check stub or in the cash  
 book shows .....\$478.00

That we may not forget why the bank account did not agree with the amount which our book showed, we should put down on the back of the stub opposite the last check which we drew, a memorandum of the above. When we start the month of February, we should begin with this balance of \$478.00, just as we began the month of January with the balance of \$512.63.

You see it is important that we should always know just how much we have in the bank; otherwise we shall be giving people orders on the bank for money that isn't there. And this would be as embarrassing as ordering two dishes of ice cream at a church supper when we have only 15 cents in our pockets!

"Checks," "Invoices," "Receipts," "Notes."

Each of these words makes the business man think of a certain form. Each word describes a paper which is made use of in practically every business concern.

Because these papers are so common in business and because every business man uses about the same kind of a form for the same purpose, it is possible to have the form printed. The words which are the same on every form of the same character are printed, while spaces

are left for those which differ.

## The Form of Bank Checks

A bank check is an order on a bank by a person who has money on deposit in that bank to pay to another person a certain sum of money.

Because every check will have a number, the name of the town or city, the name of the bank, a request to pay, and a certain amount of money, checks are printed as shown above.

Space 1—For the number of the check. Checks are numbered in the order in which they are made out.

Space 2—For the date.

Space 3—For the name of the person to whom the bank is to pay the money.

Space 4—For the amount of money the bank is to pay, the amount being written, not in figures.

Space 5—For the amount in figures.

Space 6—For the name of the person signing the check, that is, the person who has the money on deposit in the bank.

## Form of the "Invoice" or "Bill"

An invoice (commonly called a "bill") is a memorandum which one person who has sold goods or services gives to another who has bought the goods or services. The invoice should show what has been pur-



19

(3)

Dr.

(4)

(5)

Chicago, \_\_\_\_\_ (1) \_\_\_\_\_ 19  
Received from \_\_\_\_\_ (2) \_\_\_\_\_  
\_\_\_\_\_ (3) \_\_\_\_\_ Dollars  
\_\_\_\_\_ (4) \_\_\_\_\_  
\$ \_\_\_\_\_ (5) \_\_\_\_\_ \_\_\_\_\_ (6) \_\_\_\_\_



|                                                 |             |                |
|-------------------------------------------------|-------------|----------------|
| \$ (1)                                          | Chicago (2) | 191            |
| (3)                                             | after date  | promise to pay |
| to the order of (4)                             | (5)         | Dollars        |
| Payable at                                      |             |                |
| Value received with interest at (6) % per annum |             |                |
| No. (7)                                         | Due (8)     | (9)            |

Space 2—The name of the person who has paid the note.

Space 3—The amount of money paid (written).

Space 4—Why the money was paid.

Space 5—The amount of money paid (figures).

Space 6—The signature of the person to whom the money was paid.

### Form of a Promissory Note

A note is a promise in writing given by one person to another to pay a certain sum of money at some future date.

The ordinary form of a promissory note is as shown above. The

numbered spaces are for the following information:

Space 1—The amount of the note (figures).

Space 2—Date.

Space 3—When you promise to pay.

Space 4—The name of the person to whom the promise is made.

Space 5—The amount of the note—how much you promise to pay (written).

Space 6—The words "with interest" if the note is to bear interest.

Space 7—Number of the note.

Space 8—When it is due.

Space 9—The signature of the person making the promise.

## How "Home" Would Look from the Moon



"The Moon Is the Loneliest Place!"

# IN THE GREAT WORLD OF NATURE

## ASTRONOMY



### Away Up In The Sky

**S**O M E *Twinkle, Twinkle, little star,* telescope is a big  
people *How I wonder what you are* tube with a thick  
smile when glass eye at the end.

they hear that simple rhyme. Just two kinds of people say it seriously—very wise men and very little children. Little folks have

*What Your "Big Eyes" Do for You* curiosity and imagination. And wise men are careful not to lose these precious things when they grow up. It is round-eyed wonder that has found out all the beautiful secrets of the earth and sky.

The first thing in the sky at which you wondered was the moon. Did you ask mama to get it for you? You thought it was in the tops of the trees. Then you saw it was 'way, 'way up, a golden ball.

#### No Wonder the Moon Is So Neighborly

The moon is our nearest sky neighbor, for it is only two hundred and forty thousand miles away! The sun is ninety-three million miles distant! We can learn many things about the sun, moon and farthest stars by looking through a telescope. A

It is like the lens in grandpapa's spectacles, only it may be forty to sixty inches wide.

#### Day and Night on the Moon

The moon is the loneliest place! It has no air, no water, no forests, no birds or flowers or little boys and girls. There is no

*Where Nobody Is Ever "At Home"* body at home and nothing going on.

Day and night are each two weeks long, and our earth looks like a big moon from there. The moon is a globe of burned out fires—cold and dead.

#### Who "The Man in the Moon" Really Is

A walk on the moon would be over stony deserts, or along bare mountains, through pitch black valleys. You would stumble into deep holes. The jolly face of the man-in-the-moon is made up of mountain ranges and their shadows, deep ring scars miles wide, and great level plains.

Don't you wonder why the





The lamp is the Sun, in the center of the Moon's orbit is the Earth and the balls show the Moon in its various positions. Note the new moon, second quarter, third quarter and full moon.

moon can shine with such a soft light? There are two ways in which things can shine. A lamp flame glows with its own light. A looking glass reflects the flame. The moon

*Why Shiny  
Shoes are  
Like the  
Moon*

is a mirror for the sun. Our earth is another mirror. A grain of dust in a sunbeam, a polished table-top or stove, or polished shoes all reflect light. A vapor cloud is a beautiful mirror, and so is a pool of quiet water. Some of the stars in the sky are suns, shining by their own light. Some are dark globes of planets and moons; some glowing vapors and whirling masses of star dust.

#### How the Earth "Leads" the Moon

The moon circles around the earth and moves with it around the sun. It is like a little dog led by a string.

*But It  
Isn't the  
"Dog"  
Star*

The string is the pulling power of gravity. The moon also pulls. They cannot break loose. So the sun pulls the earth, and the earth pulls the sun, like a ball on the end

of a whirling string and so, like the other stars, is kept in its track.

#### What Makes the Moon's Changes

The only side of the moon that *can* shine is the side facing the sun. Once every month it comes between the earth and sun and we cannot see its shining face at all. In a day or two we can see the narrow, western edge of it, gleaming like a crescent of pearl. Every evening, as the moon moves eastward, farther from the sun, we see more of it. In two weeks the full moon comes up in the east, after sunset. Then the western edge is darkened. It takes the moon four weeks to travel around the earth. Except near the time of the month when we have a new moon or a full moon, we can sometimes see the moon in the day time.

We cannot look at the sun except through dark gray or smoked glasses. It blinds the eyes with its glare.

*What the  
Sun Spots  
Told Us*

The heat of the sun is greater than any heat we are able to make on earth. It is thousands of times bigger than the earth, but is not solid. It is an e-nor-mous ball of glowing vapors or gases. Scarlet flames, thousands of miles high, leap up and roll around the sun, topped by crimson clouds. In places the sun sputters, as when water falls into a kettle of hot lard. This makes dark spots that seem to move across its face eastward, disappear and return on the western edge. By watching the sunspots astronomers have learned that the sun whirls from west to east, just as the earth and moon do. It takes the sun twenty-five days to turn around once. It is now thought that the sun-spots are

## How You Can Measure the Moon



Most people think only very learned men with complicated instruments can measure the moon, but any bright boy can do it for himself—especially if he has a little sister by to play she is helping him. First, make a small frame, as shown in the illustration, with the two edges three or four inches apart. Place the frame, some evening about two or three hours after moonrise, on the railing of the veranda. Then, looking through the frame, move back until the moon seems to just fill it. Carefully locate the position of your eye, by taking a table and placing a book on it, then moving table and book back until the corner of the book just touches your eye as you see the moon through the frame. Next, take a cord that will not stretch and measure the distance from the corner of the book to the lower edge of the frame. Measure also the distance between the edges of the frame. The distance to the moon is 239,000 miles. If you have reached Proportion in your study of Arithmetic you can now measure the moon, for the distance from your eye to the frame is to the distance between the edges of the frame as the distance to the moon (239,000 miles) is to the diameter of the moon.

made by cool vapors falling in. And whew, how windy and hot! For these vapors are whirled in great electric cyclones, or circular storms,

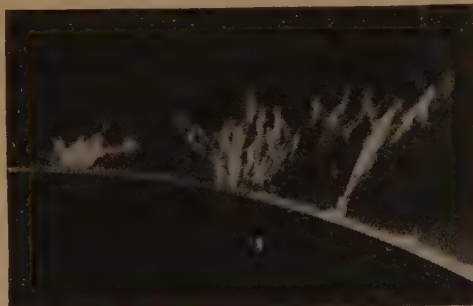
like our wind storms on earth.

#### How We Got to Know Mr. Sun

We learn about the sun by study-

ing his photograph and, through the spectrum, his light rays. The moon also helps by coming between the sun and the earth. Then, all around the edge of the black moon that covers the center, is a corona of light, of delicate pearly white, with red jewels of clouds in it. From that long banners stream away

*How  
Mr. Moon  
Introduced Us*



This is a photograph of the flames on the sun shooting up 50,000 miles—over six times the earth's thickness.

into space. Eclipses are photographed. The light rays are caught in glass prisms and spread into rainbow bands of color.

### Why the Sun Is Your Grandfather

Did you know that our good Mother Earth is one of the sun's children? The sun has a family of big and little planets.

*The Ring  
Master and  
His Circus*

Each one travels on a different circle, at a different speed.

The sun, in the middle, is like a ring-master in an eight-ring circus. He cracks his whip and his planets, with their tagging moons, gallop around their tracks. The earth is on the third track. We can see six of the brother and sister planets, that circle with us around the sun, without a telescope.

## Mother Earth's Traveling Companions

JUPITER and Saturn go around the sun in circles much larger than the earth's. They move slowly among the stars changing position but little from night to night. Mercury has the smallest track, nearest the sun. It goes around four times in one of our years. It flits in and out of our sky like a fire-fly. Mercury and Venus are seen only in the morning and evening sky, never at midnight. It takes Venus nearly twenty-three, and Mars twenty-three months to make the circuit.

*Christmas  
Only Every  
Other Year!*

the queen of beauty. A glittering gem, truly "like a diamond in the sky," part of her brightness is due to vapor clouds. As Venus is between us and the sun she, like our Lady Moon, shows her various phases as she mounts the sky, moving eastward among the stars. When this sparkling point of light appears, with the pearly sickle of the new moon, on the azure sky of early evening, their beauty makes you catch your breath, as when you hear a strain of lovely music.

*As Beau-  
tiful as  
Music*

### Our Nearest "Uncle"

#### The Beautiful Queen of Night

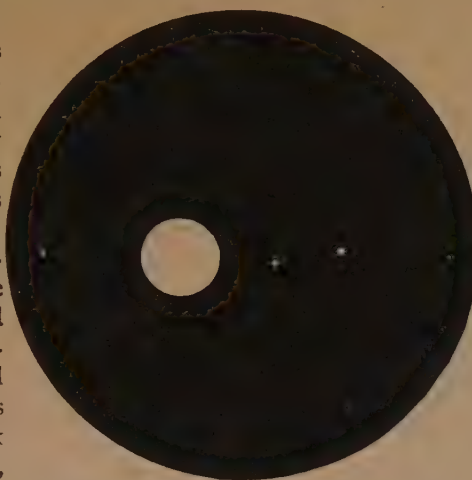
Sometime you will see Venus above the sun, after sunset. Such a beauty! She was named Venus for

You can see a thing best when the light shines on it over your shoulder. Mars is on the next circle outside the earth's, so we turn our backs to the



sun to look at it.  
Of all the sun's  
children  
*Maybe* children  
*People Live* only  
*There, Too* Venus

is nearer than this  
dull red planet.  
Through a tele-  
scope we can see  
great dark and  
yellow areas, pos-  
sibly fields and  
deserts, lines  
thought to mark  
canals of water,  
white ice-caps at  
the poles, two  
moons and vapor  
clouds. People  
may be living on Mars!

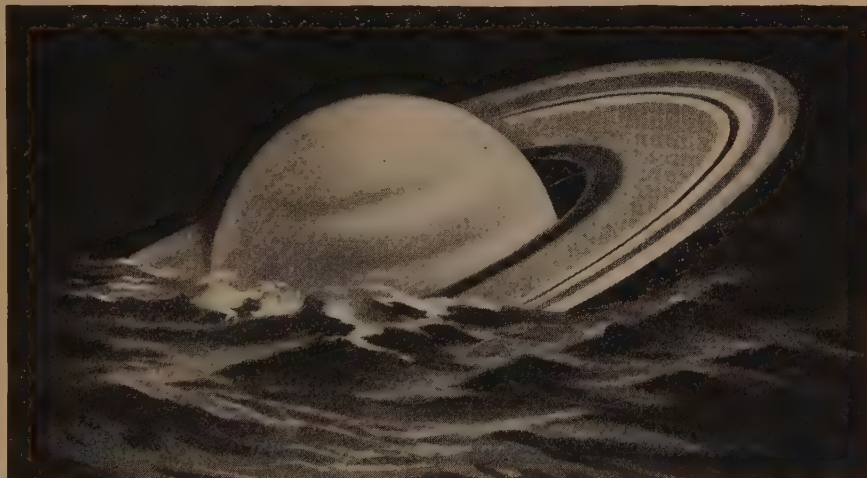


Jupiter and the Four Largest of His Moons

just a big globe of glowing gas, with  
rings of star-dust.

Jupiter, next beyond Mars, is a The reason why we can find the

If Saturn Should Fall Into the Sea



Courtesy Scientific American © Munn & Co.

Saturn is merely a mass of hot gas and if he should fall into a sea big enough to hold him, he would float like a big cork.

big, young, hot world. It may be all  
fluid, melted rocks and water, as  
our earth was when it  
was young. This planet  
is as busy making steamy  
vapors as a singing tea kettle on a  
hot stove. Except when beautiful

*Uncle Jupiter*  
*and His*  
*Nine Moons*

planets among the thousands of  
stars in the sky, is because they are  
wanderers; bright vis-  
itors coming and going  
among the other stars.  
All the others that we can see are  
in fixed groups. As the earth makes its

*Grouping*  
*of*  
*The Worlds*

journey around the sun, it finds these star-groups in the same places every

path of the sun. It is there you should look for the planets.

#### How the Little Bear Trots Around the Pole Star



Here we see how the Little Bear swings around the Pole Star as the positions of the constellations change in the heavens.

year, as if they were painted, or studded like jewels on the sky.

#### An Easy Group to Find

The easiest star-group, or constellation, for you to find is the Big Bear, or Dipper. It is always in the north. The two stars on

*Find the Big Bear and His Family*

the outer edge of the cup point to the polar star.

That forms the end of the handle of the little dipper. Opposite the big dipper is Cassiopeia's chair of six stars. These three star-groups appear to circle around the polar star every night, and every year.

All the stars appear to move from east to west, just as the sun does.

*Why the Stars Seem to Move to the West*

But it is really the earth that turns from west to east, leaving sun and stars behind. Outside

of these three groups near the polar star, is a larger circle of constellations. A still larger one crosses the sky, a little south of overhead, in the

#### Strange Fancies of the Ancients

There are eighty-nine of these star-groups. Centuries ago people fancied that certain constellations had the outlines of animals. Some of them were named for the bear, the dog, lion, bull, dragon, scorpion. Other clusters were called the twins, the crown, the lyre. And some were named for great heroes and heroines, like Hercules, Perseus, Orion, Cassiopeia and Andromeda. Then the moon was called the car of Diana, queen of the night and huntress of the skies. The sun was the fiery chariot of Apollo. The planets were named for the gods of the Greeks.

Some star-groups are easier to find than others, because of the bright stars in them. Sirius, the dog A "Dog" star, in the big dog group, is the brightest star in the sky. It is a blazing white sun, many

times larger than our sun, but much farther away. You can see it, low in the south, in mid-winter, or above the rising sun in August. Vega is a beautiful blue-white sun in the small lyre group. In July evenings it is nearly overhead. Arcturus is a yellow sun, in the south in summer.

#### Where the Comet Gets Its Tail

When the papers report that a comet is coming you should watch for it. A comet is a starry wanderer with a shining tail. The tail is

*Why the Comet Switches Its Tail*

made of vapors, or of dust blown out of the comet by the force of the sun's rays. The tail

always points from the sun, switching around to the other side when





# Twin Jewels

of the  
Sky



There are twin stars as well as twin people. Another strange and beautiful thing about these twin or "double stars," as they are called, is that they have many colors. All of these double stars are really far apart—sometimes millions of miles apart. Some appear double because they are nearly in a straight line with the earth. Others are real twins, revolving about one another.

In the Great Bear, 1, is a pretty yellow star with a greenish-white companion. On the left, 2, in Andromeda, is a rich golden-yellow star with a blue companion. To the right of this, 3, in Cassiopeia, is a yellow star with a purple one by its side. In Bootes, 4, is a greenish-white star with a steely blue companion. In the same constellation, at 5, is the largest and one of the most beautiful double stars in the heavens. The larger one is a bright yellow; its companion is of a clear sapphire blue. Below this, in 5, is another double star—one yellow, the other a bright red. At 6 in the constellation of the Swan we find a reddish-yellow star with a light blue companion. To the right, 7, in Hercules, is a pale yellow star accompanied by a reddish one. At 8 in Ophiuchus is a pretty yellow star with a faint bluish companion, and in the same constellation, at 10, star with a reddish companion. Below that, in Capricornus, is a large golden-yellow star with a light blue companion.

## OUR NEIGHBORS IN THE SKY

### Story of the Constellations

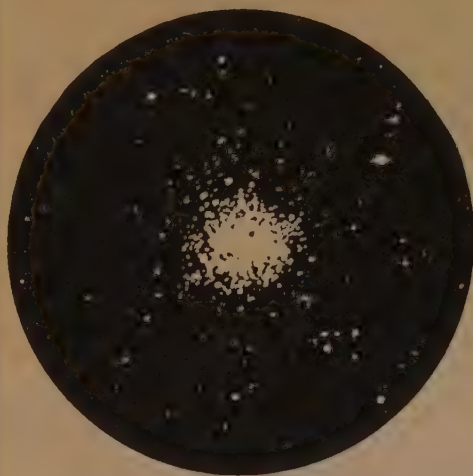
*Why did not somebody teach me the constellations and make me at home in the starry heavens which are always overhead and which I do not know to this day?*  
—Carlyle.



On the Great Bear's left, the man with the whip is Auriga, the Charioteer. He is carrying Capella, the Goat, who nursed Baby Jupiter. Perseus, with his shield, carries the head of Medusa of the Snaky Locks and is about to rescue the beautiful Andromeda, who is chained to a rock. In the chair is Cassiopeia, mother of Andromeda, who after Andromeda's rescue was chained to her chair and swung round and round the pole. This constellation is the well-known "W" which you can easily find. By Cassiopeia's feet is her husband, Cepheus, King of Ethiopia. Only the head and forelegs of Pegasus, the Winged Horse, are represented in the sky. The Sea Goat with the fish's tail, is Capricornus. On the right of the picture, Boötes carries his sickle, herdsman's crook. Next is Hercules with his club. Below Hercules is Ophiuchus, the Serpent Bearer. Near the center of the sky is the Swan. Next is the Winged Lyre and below Aquila, the Eagle, carries Ganymede to Jupiter to be his cup-bearer. It takes nearly ten years for light to travel from Albireo, the star in the swan's head, to the earth, so you will not see this star as it is when you look at it, but as it was ten years previous.



# Through the Astronomer's Great Spy Glass



These pictures show a star cluster and a nebula as you see them when you look at them through a big telescope. Just imagine you are that young man studying them through that great "spy glass."

the sun is passed. Then this tail disappears, like the tail of a tadpole when the tadpole turns into a frog. All suns may be blowing dust out of small bodies that get too near them, for there is star-dust, and even rocks, all through space.

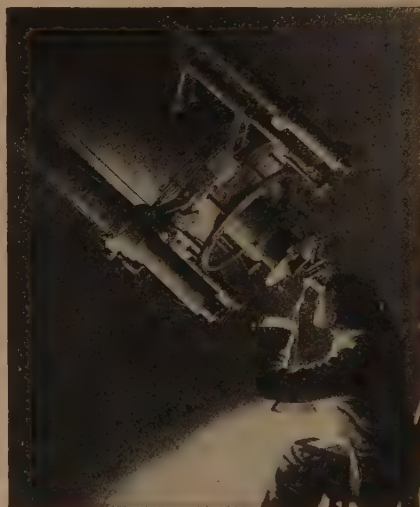
## What Is a Shooting Star?

Sometimes a rock, or meteor, or even a shower of meteors, strikes the earth's atmosphere. They melt and

*When the Earth is "Shot" by a Star* flash across the sky as shooting stars. Some fall to the earth and make holes, for they hit like bullets. That gives one explanation of the big, round holes on the plains of the moon. They have long been thought to be volcano craters. But another theory was that the moon was pelted by great hot meteors weighing tons, that struck it like cannon balls.

## The Milky River of Stars

And the Milky Way—that pearly path that straggles across the sky. It is just what it looks to be—a wide



Courtesy Scientific American. © Munn & Co.

river of countless stars set close together, and so far out in space that they can just send us that faint light. On either side of it is a dark band, where there are few stars. Stars seem to cluster, or draw together, in some places in the sky, forming the groups we have mentioned while in other places there

*What Makes Stars Cluster*



are but few. These sky spaces are only "sparsely settled," one may say.

### Do Starry Worlds Capture Each Other?

It has long been thought that our sun and all its planets were once one whirling mass of fire, vapor and star-dust; that the central fire shrank in on itself, and the outer rings broke up into planets. Another

*How New  
Worlds  
are Made*

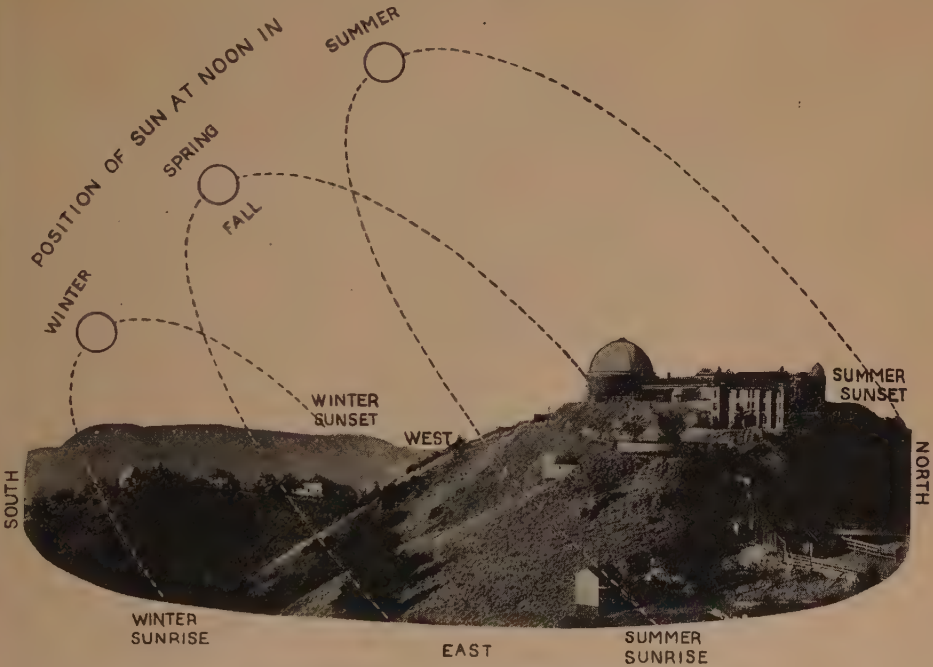
turing shooting stars, or meteoric rock.

### Wonderful Glasses Astronomers Wear

Like weather men astronomers have many instruments. Their tools are all explorers of space. Telescopes can find stars that are located countless millions of miles away! Stars are caught with telescopes, re-

*Seeing Many  
Thousand  
Million Miles*

### How The Sun Helps Make Our Seasons



Here is shown the position of the sun at noon in winter, spring and summer. On the hill to the right is an astronomical observatory.

explanation offered was that the sun hurled big and little pieces of itself out, to form planets, and the planets made their moons by similar explosions. Another possibility is that the sun, with its pulling power, captured the planets that were wandering in space. Then the planets captured the moons. Our moon may be a dead planet, as it looks to be. The earth is still cap-

flected in mirrors, and the images are photographed. Light rays are split up into colors, and made to tell what substances are in a star; whether a star is a solid, a vapor, a gas or a mass of star-dust.

What do you think is the most interesting thing in the sky to an astronomer? It is a patch of cloudy light that you might not notice at all. These patches are called nebu-

læ. "Nebulous" means misty. Most of them are spirals of glowing gas, vapor or dust, whirling around a starry center. It is now thought that all suns and planets began as nebulae. By studying them it is hoped to find the secret of the skies—how worlds and suns are all the time being made and unmade.

### The Old Myth Stories of the Stars

Before the days of books the sky was a great story and picture book. The sun, moon, star-groups, planets and brightest sun-stars, were heroes of many a tale, or the dwelling places of the gods. These myths grew out of religious beliefs, so they were beautiful and poetic.

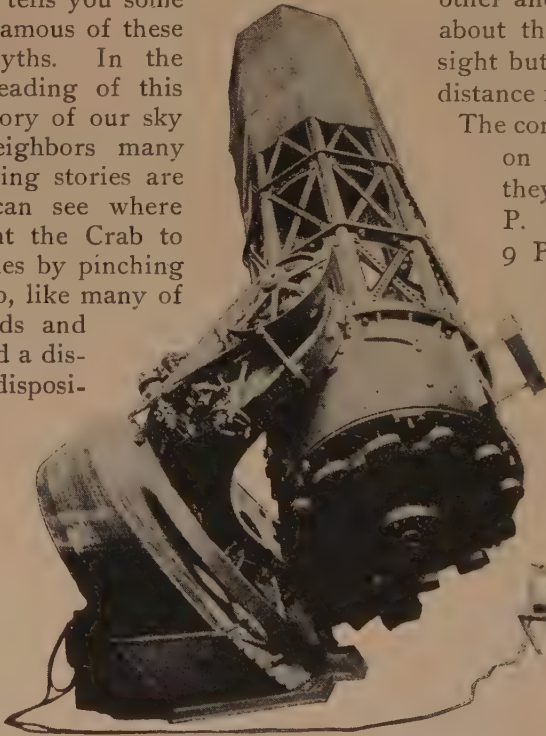
In the artist's Story of the Constellations he tells you some of the most famous of these

*Myth  
Stories the  
Stars Tell*

myths. In the heading of this story of our sky neighbors many other interesting stories are told. You can see where Juno has sent the Crab to annoy Hercules by pinching his toes. Juno, like many of the other gods and goddesses, had a disagreeable disposition. She was always doing ugly things to annoy people she didn't like. In his right hand Hercules holds his big club and in his left a branch around

which serpents are twining. Over his shoulders is the skin of the Nemean Lion, the killing of which was one of his famous Labors. Bo-ó-tes, the Hunter and Herdsman, is pursuing the Great Bear with his dogs. The dog with his feet in the air is the Greater Dog, and the star near the end of his nose is one of the most brilliant in the heavens. Not many people know that the Great Bear and the Great Dipper are one. The Great Bear was once a beautiful woman, Callisto. Juno, jealous of her beauty, changed her son into a Little Bear and put them both in the sky. But that hateful Juno fixed it so they could never approach one another and so they wander about the pole always in sight but always the same distance from one another.

The constellations shown on page 303 are as they appear at 10 P. M., August 23; 9 P. M., September 8; 8 P. M., September 23. Lying on your back holding the picture before you in such a way that north points north, study one constellation at a time and then go out and locate it in the sky.



By means of the electric switch box which you see in the chair, the astronomer controls the motions of the telescope so as to keep it fixed on the objects he is looking at.





# Long, Long Journey



Here you see the planets as they appear through a telescope; Venus with a few hazy marks, Mars with others that scientists think may be canals. You readily recognize Saturn by his rings.

Venus is the brightest star we have and is always seen near the horizon just after sunset. Mercury looks like a rather bright star, but is always twinkling violently—like the eyes of a laughing boy. None of the other planets twinkle. This helps us to distinguish the planets from the fixed stars without the aid of a tele-

scope. Uranus is just on the limit of visibility without a telescope. He can only be seen during the summer months if one knows just where to look. Neptune is so far away that he is never visible to the naked eye.

The nearer planets, Venus, Mercury and Mars, show phases similar to the moon. The planets that are farther away, though, show the phases very faintly—some not at all. Jupiter, although the Earth's Biggest Brother, whirls much faster than the earth. It

# to Distant Worlds







## The Wind and the Moon

*Said the Wind to the Moon, "I will blow you out;  
 You stare in the air  
 Like a ghost in a chair,  
 Always looking what I am about—  
 I hate to be watched; I'll blow you out."*

*The Wind blew hard, and out went the Moon.  
 So, deep on a heap  
 Of clouds to sleep,  
 Down lay the Wind, and slumbered soon,  
 Muttering low, "I've done for that Moon."*

*He turned in his bed; she was there again!  
 On high in the sky,  
 With her one ghost eye,  
 The Moon shone white and alive and plain.  
 Said the Wind, "I will blow you out again."*

*The Wind blew hard, and the Moon grew dim.  
 "With my sledge and my wedge,  
 I have knocked off her edge!  
 If only I blow right fierce and grim,  
 The creature will soon be dimmer than dim."*

*He blew and he blew, and she thinned to a thread.  
 "One puff more's enough  
 To blow her to snuff!  
 One good puff more where the last was bred,  
 And glimmer, glimmer, glum will go the thread."*

*He blew a great blast, and the thread was gone.  
 In the air, nowhere  
 Was a moonbeam bare;  
 Far off and harmless the shy stars shone—  
 Sure and certain the Moon was gone!*

*The Wind he took to his revels once more;  
 On down, in town,  
 Like a merry-made clown,  
 He leaped and halloed with whistle and roar—  
 "What's that?" The glimmering thread once more!*

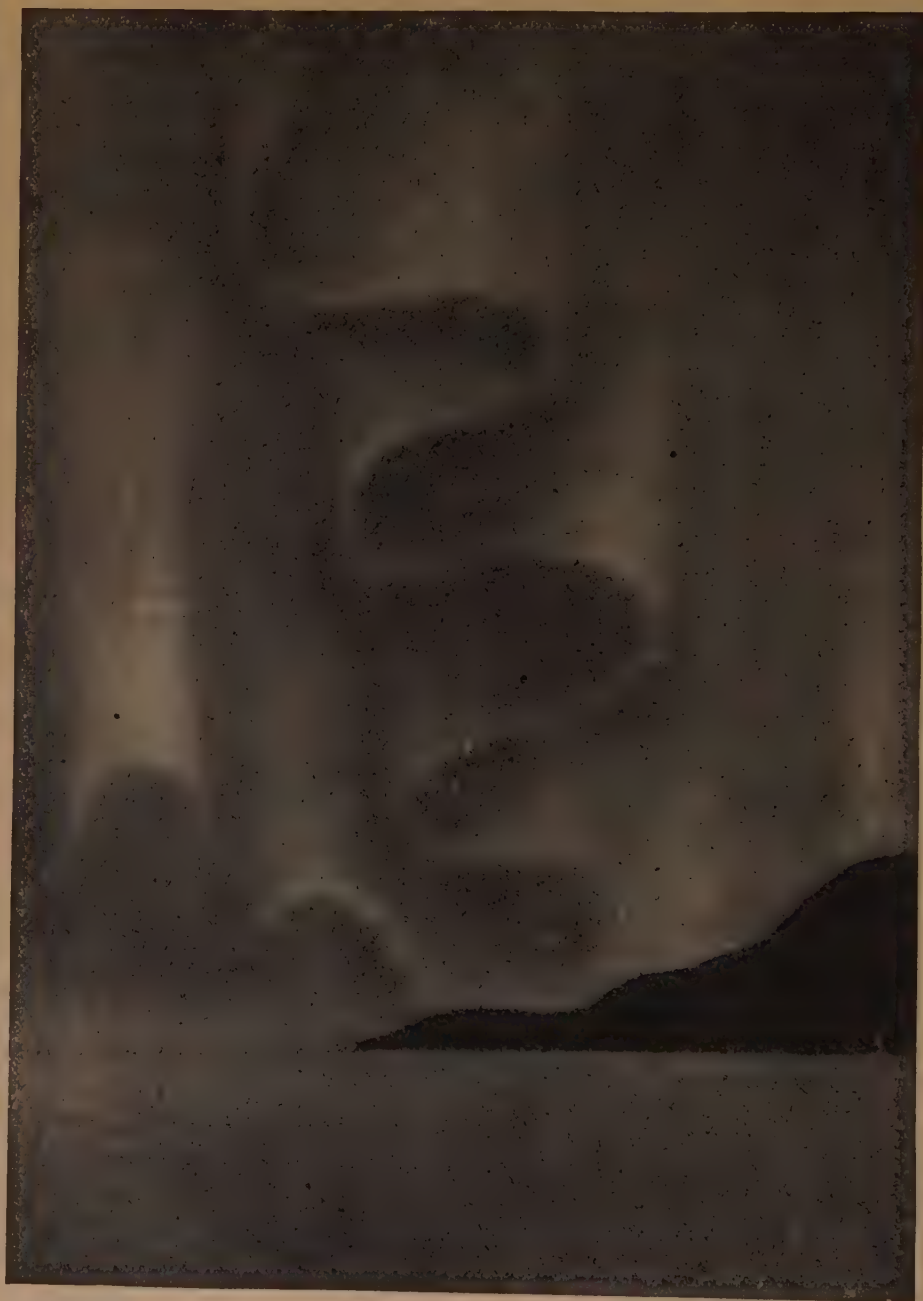
*Slowly she grew—till she filled the night,  
 And shone on her throne  
 In the sky alone,  
 A matchless, wonderful silvery light,  
 Radiant and lovely, the queen of the night.*

*Said the Wind: "What a marvel of power am I!  
 With my breath, good faith!  
 I blew her to death—  
 First blew her away right out of the sky—  
 Then blew her in; what strength have I!"*

*But the Moon she knew nothing about the affair;  
 For high in the sky,  
 With her one white eye,  
 Motionless, miles above the air,  
 She had never heard the great Wind blare.*

GEORGE MACDONALD

## A Great Curtain in the Sky



No form of the aurora is more strange and striking than what is known as the "auroral curtain." And stranger still, as new folds are formed in one direction the curtain vanishes away in another. First it comes in varied rays of light, and then these imperceptibly fade away.

# The Mysterious Lights of the Frozen North



**A**URORA means light. In old Greek myths Aurora was the rosy goddess of morning. Boreal means "of the north"—northern lights. "Aurora Australis" is astronomy language for "southern lights." Both are often called polar lights. But this is not correct. The wonderful plays of light are not seen near the poles but along latitudes 70 to 60. About once every eleven years they are seen as low as 40. The long, dreary nights of Arctic winter are often relieved by quivering sheets, moving pil-

lars, fluttering curtains and streamers, and rayed arches of brilliant sunset colors that mantle the sky and illuminate the snowy landscape for hours at a time. They are most often seen before or after violent storms, when there is an electric disturbance. The magnetic needle in the compass, too, is unsteady during the display. Benjamin Franklin thought the northern lights were caused by discharges of electricity. Spectrum analysis indicates that auroras may be glowing

*When the  
Compass  
Gets Excited*





Another Form of the Curtain Aurora



"The long dreary nights of Arctic winter are often relieved by quivering sheets, moving pillars, fluttering curtains and streamers, and rayed arches of brilliant sunset colors that mantle the sky and illuminate the snowy landscape for hours at a time."

Fourth of July Every Night



"How would you like to live—or, at least, spend a little while—in the Land of the Eskimo, where you could see such grand 'fireworks'? The Eskimo takes the same delight in them as if he were always a child."

gases. They are seen more frequently when large spots appear on the sun, which, it is now thought, are caused by electric cyclones. Astronomers are much interested in auroras for they seem to be mixed up with the weather of the earth and the sun.

How would you like to live in the land of the Eskimo, where you could see such grand "fireworks"? The Eskimo takes the same delight in them as if he were always a child.

In the picture at the head of this article he is sailing by the light of the aurora in his kayak and he has his eye on that walrus just ahead of him. The Eskimo in his kayak is a match for any walrus. And how he can manage that kayak! It makes no difference to him if he turns upside down or if his head gets into the water. He immediately rights himself. The kayak is waterproof, and some Eskimos become so expert in the use of it that they can turn complete somersaults in the water—as easily as a

"bird man" can turn over in his flying machine. Getting into a kayak is much the same as mounting a broncho. He brings it up alongside of a stone or cake of ice and steps gingerly in. If there is nothing on which to mount, he crawls along the kayak until he comes to his seat. Getting out of a kayak is worse than trying to undress in the upper berth of a sleeper, going at the rate of sixty miles an hour. Those ice-

bergs you see are about seven-eighths of their mass in the water. They have been known to measure two and one-half miles in length and as much in width. Such a mass of ice weighs about two thousand million tons, or enough to

make three hundred thirty pyramids of Egypt.

This is how icebergs are born: The snow falls and freezes until in many places it is ten thousand feet deep.

This snow is very heavy and is naturally squeezed out at the edges. Advancing into the water it is raised by its own buoyancy and soon breaks off in these monstrous masses.



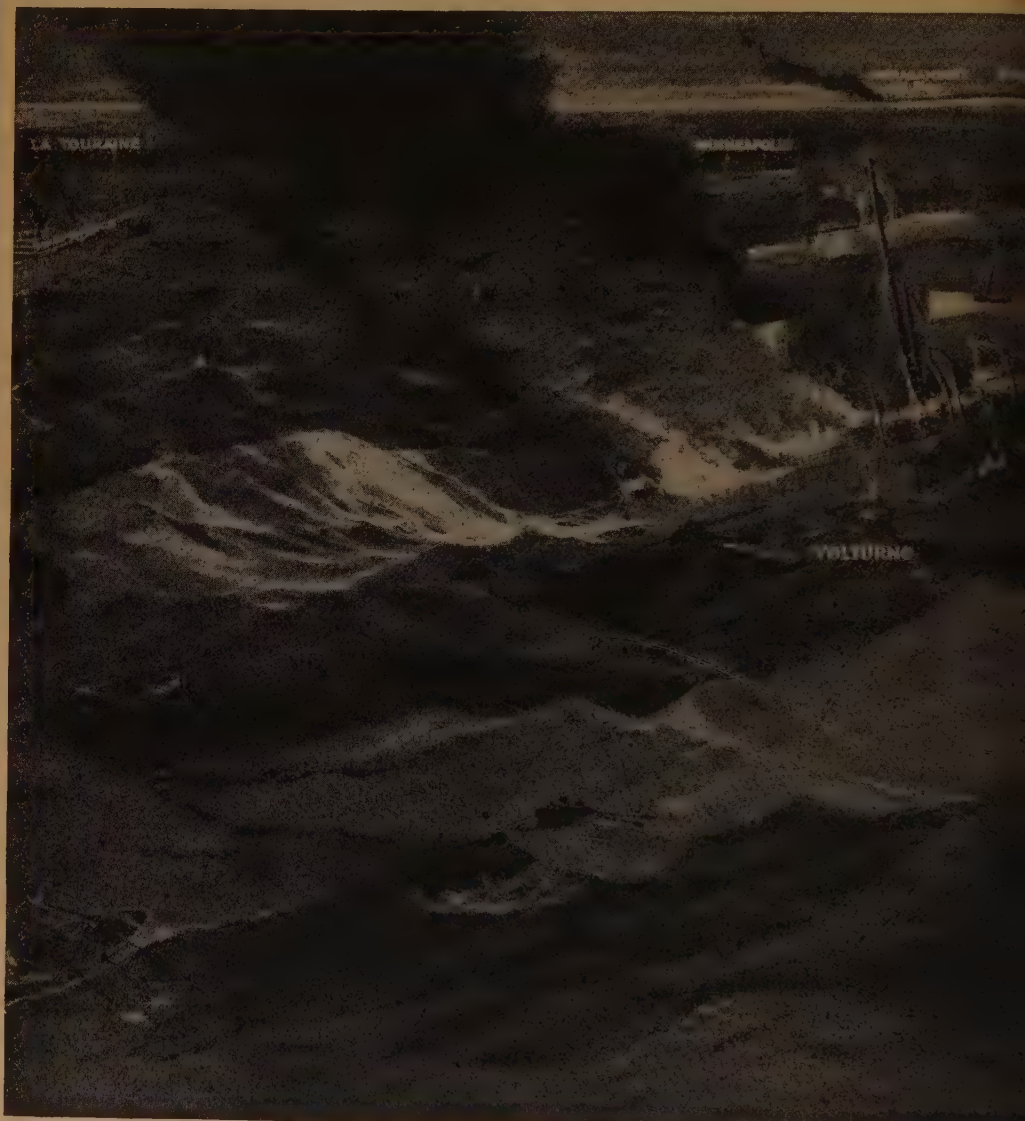
**The Serpent Aurora**  
Sometimes the Aurora takes the form of a fiery serpent.

*In the North behold a flushing; then a deep and crimson blushing;  
Followed by an airy rushing of the purple waves that rise!  
As when armed host advances, see, a silver banner dances,  
And a thousand golden lances shimmer in the Boreal skies!  
The vision slowly dies!*

JOSEPH KEARNEY FORAN



## Ships of all Nations Answer



In October, 1913, when fire broke out on the Volturno, a two-thousand-ton vessel help was sent out. The fire was caused by the explosion of some chemicals in the plosion occurred at 6:50 a. m. At 11 that same morning the Carmania arrived in Volturno, dispatching life boats and pouring out oil to calm the heavy seas so that but without the wireless the loss of life would have been much greater.



## ng a Wireless Call for Help



which was carrying Russian and Polish immigrants to Canada, a wireless call for hold. It reached the upper deck, and soon the whole ship was in flames. The ex-  
response to the message of the wireless. Soon ten other vessels surrounded the  
the life savers could make headway. Not all those aboard the Volturmo were saved,

# What Is The "It" That Rains?





# IN THE GREAT WORLD OF NATURE

## THE WINDS AND THE WEATHER

A Visit to

### The Man With a Hundred Eyes

THE artist has told so much of the weather story in his interesting picture that we were really afraid we wouldn't get to talk to you at all, because there wouldn't be anything left for us to say!

#### Myth Stories of the Weather

You see he begins with the most ancient thing about the weather—the weather myths. Weather is such a tre-men-dous thing that men have always been interested in it and wondered about it and tried to account for it.

The Chinese, as you see by the quaint old rain gauge with the Chinese characters on it, measured rainfall very much as we do with our rain gauge of today. (The Chinese weatherman's gauge looks like a tea chest, doesn't it?)

On the left in the sky is Thor, god of thunder. According to Norse mythology he was the "It"

*What a  
Noise  
Thor Made!*

that rained and the thunder was the noise his chariot made in rolling through the clouds—like the noise of a lumber wagon going over a wooden bridge. On the right is the sun god as the Greeks and, after them, the Romans, thought of him. They could see what great things the sun does in bringing back the seasons and making things grow, but they didn't even suspect that he, with the aid of the winds, which he also helps to keep going, is one of the most

important parts of the "It" that makes it rain.

#### Waltz of the Winds

But now let's see if we can't discover the real truth about the weather and the winds it rides on from what there is in the picture. Which way is the little wind sprite blowing that

you see just in advance of Thor? Now, which way is the wind blowing that is driving the ship toward the cliff? In just the opposite direction. And yet this is all one and the same wind. "How can the same wind be blowing in two opposite directions at the same time?" you ask, puzzled. And no wonder, for it puzzled the scientific men for a long time; until our wise Benjamin Franklin suspected the truth, which is that the winds move just like two happy little people waltzing across a room—turning round and round and moving forward at the same time. So Franklin had friends in different parts of the country note the direction of the wind at a given hour on a given day. Then he put all these directions down on a diagram very much as you see in those queer little marks that look like darting water bugs on the weatherman's map. And, sure enough, when he came to connect all these directions it made a circle—although not a perfect circle. Later in this



story we will tell you how these immense wind wheels are formed.

Notice on the horizon back of the sea the sand columns in the desert. These are formed by whirling winds.

*The Winds and the Sphinx's Nose* They are like the little dust columns that go whirling over the dry country roads in summer

time. Notice how the camels are hurrying away, for this is one of the terrible desert storms called simoons. And there sits the sphinx, gazing with his mysterious eyes across the desert. On another page you can come closer to Mr. Sphinx and see where these same desert winds have carried away his nose by flinging sand against it for centuries and centuries.

#### The Weather Man and the Frogs

Tell you about the old man and his dunce cap? The dunce cap is really the cap worn by ancient wise men called astrologers, who used to undertake to foretell the weather by reading the stars.

*That Queer "Dunce" Cap* When they put such caps on the heads of boys who didn't get their lessons it was meant to be sarcastic. Here the playful fancy of the artist has shown one of these ancient weathermen explaining to a group of frogs the meaning of the weather map. Of course frogs are interested in the weather. The rain-frogs often talk about it. The Weather Man is illustrating what he says with a weather map showing the great Galveston cyclone. He points with one hand to the region in which the hurricane began and with the other hand, to the record of the barometer, that wonderful device by which the storm guest writes his name on

the register hours and hours before he arrives.

No wonder the frog with the glasses looks alarmed! I'll warrant you that he didn't know before that the weather that keeps the pond filled up and brings down the fresh, sweet rain drops that he loves so well could do such a ter-ri-ble thing as make cyclones and hurricanes.

Notice the globe on which another frog is sitting and how the arrows are whirling around the pole.

*More Things the Frogs are Telling* These arrows are saying that the winds have a regular path around the pole where they keep

going round and round like the horses in a circus. The frog who is carrying the rule is telling us that the Weather Man, in making his predictions, takes into consideration the height of clouds. The frog at the telephone tells us that the Weather Man gets weather news from all over the country and puts it together to find out what is going to happen next. That is why we call him "the man with the hundred eyes." He sees with the eyes of other weather men scattered all over the country who report to Washington and other weather predicting centers.

#### Other Things the Picture Tells

The picture also shows the kind of barometer in which a little man comes out with an umbrella if it is going to rain and a lady comes out with a parasol if it is going to be fair weather. Near by is a duck watching the instrument which tells how fast the moisture is evaporating. Notice the scale with which this evaporation is measured—just as a grocer measures sugar.

On the house is a weather vane—such as you see on people's barns. It shows the direction of the wind

and below it the instrument which shows how fast the wind is blowing. It looks like a whirligig turned wrong-side up, doesn't it? The cups on the end of it are to catch the wind. And now that I have pointed out so many things in this "moving picture," see if you can find for yourself where Father Robin is making an umbrella of his wings to shelter Mama Robin and the babies. Papa Robins *do* do this very thing!

## How Did the Weather Man Know?

"It's going to rain." So said the Weather Man in weather language.

How did the weather man know?

Friday was a beautiful Autumn day, with soft, hazy sunshine and a light breeze from the east. But the weather man said, in the morning papers—and this is just how he said it:

"Unsettled weather Saturday and Sunday, with showers; colder by Saturday night; moderate to brisk south winds, shifting to northwest by Sunday night."

Now, how did the weather man know all that before it happened? Up in his weather station tower could he see cold and rain coming, on the wings of the wind?

## The Man With a Hundred Eyes

Yes; but he had the eyes of more than a hundred other men in weather stations scattered over our big coun-

try to help him. And he had tools.

You never heard of weather tools? Oh, yes, you have. You have a thermometer-e-ter in your school room. The mercury in the tube is a messenger boy. It climbs with the heat and falls back with the cold. It tells you the temperature of the air as plainly as a clock tells the

*Tools for  
Taking the  
Weather  
Apart*

time of day. And you must have seen metal arrows turning on pivots above house gables. They are weather vanes. They point whichever way the wind is blowing. A pinwheel of paper, whirling on a stick, will show you how fast the wind is blowing.

In the curious toy house where in fair weather a lady walks out and when it feels like rain a gentleman appears with

an umbrella, the figures are moved by fiddle strings that stretch in damp, and shrink in dry air.

Some of the weather man's instruments are very simple. Any school could put up a weather vane.

Children could make a rain gauge of a jar with a funnel lid, and measure a heavy rainfall with a ruler. They could e-vap'-o-rate water from a five-cent glass test tube, and find out how much vapor the air was taking up. But other weather instruments are as full of delicate wheels and

I Count the Raindrops



This is a rain gauge with which scientific observers measure the amount of rain that falls during a given time. That little bent tube prevents the water from evaporating before it is measured. When the last drops have run out of the funnel there is still some water left in the tube because water cannot rise higher than its source. This water acts like a cork so that the moisture evaporating from the water in the gauge cannot get out.

springs and things as a watch. Would you like to peep into the weather man's workshop?

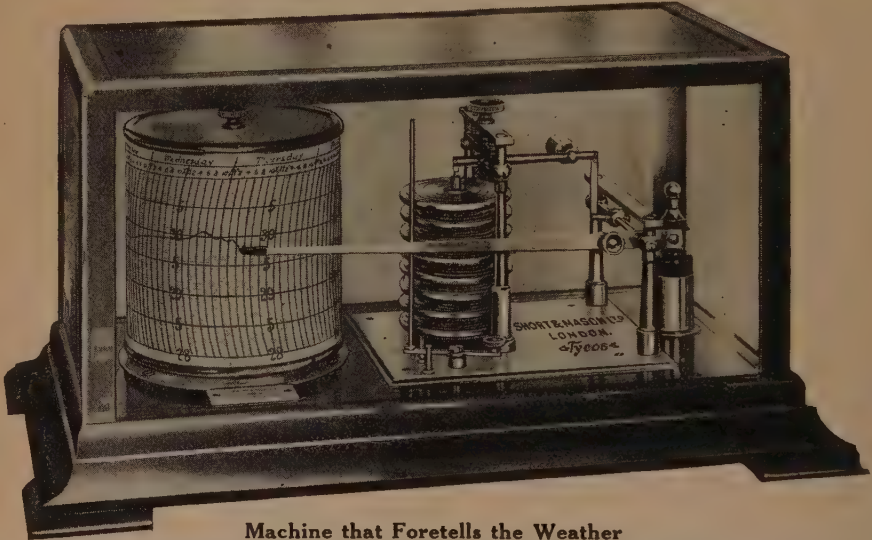
### In the Weather Man's Workshop

Many of his instruments look like clocks, grocer's scales and gasmeters. Most of their names end in "meter,"

thin metal box in the case is partly emptied of air. When the air outside is heavier than the "A Little Damp," air inside it pushes the "Says the Hair" sides of the box in. That sets a wheel in motion and turns a hand on the dial.

In another kind of meter a human

### How the Storm Writes Its Name



### Machine that Foretells the Weather

This is a recording barometer, the ingenious instrument that foretells the weather by making the weather guest register many hours before he arrives. A gradual but steady rise indicates settled fair weather. A gradual but steady fall indicates unsettled or wet weather. A very slow rise from a low point is usually associated with high winds and dry weather. A rapid rise indicates clear weather with high winds. A very slow fall from a high point is usually connected with wet and unpleasant weather without much wind. A sudden fall indicates a sudden shower or high wind, or both.

which means "measure." A gas meter measures the gas you burn. A moving hand marks the amount on a dial. The thermometer, or thermo-meter, is a heat measurer. The anemometer is a wind measurer; the hygrometer a water-in-the-air measurer; the barometer an air-pressure measurer. Electricity, the force of the wind and the height of the clouds are all calculated by the weather man.

One of the best barometers is shaped like a flat, round clock. A

hair is made to tell a great deal about dampness. Naturally curly hair curls tighter on a moist day, but straight hair becomes straighter. Hair stretches in wet weather, shrinks in dry, so a long hair, set in a frame, moves a delicately balanced hand over the dial of the hygrometer. The wind measurer is a whirligig. On the ends of four short arms are hollow cups that catch the wind, and set this "anemometer" to spinning. A dial shows how many times the cup whirls around the circle in a min-



ute. It is easy then to figure out how many miles an hour the wind is traveling.

## Reading the "Mind" of the Clouds

A weather man looks up to the sky to see if there are any clouds, what kind of clouds they are and

rus cloud. It often travels south or east when the wind on the earth is going west or north. It is so high, as high as mountain tops, that it is in a different current of air. The cirrus cloud is thought

*The  
"Little  
Bo Peep"  
Cloud*

## Not Waves of the Ocean, but Clouds of the Sky



Clouds photographed from a flying machine in California. The tops of pine trees and mountain peaks show through like islands in the sea.

how much of the sky is covered by them. All clouds, you know, are made of vapor. Fog is a cloud that lies on the ground.

Some clouds mean rain right away; others will travel farther before falling in rain. As clouds do not all look alike a weather man can tell just what each kind is likely to do.

A cloud made of little fleecy tails trailing after each other in the sun, like Little Bo Peep's sheep, is a cir-

rus cloud. It often travels south or east when the wind on the earth is going west or north. It is so high, as high as mountain tops, that it is in a different current of air. The cirrus cloud is thought

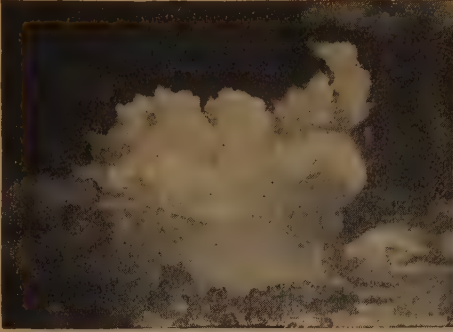
to be frozen. Think of a cloud of sparkling frost wool, floating three miles high!

The stratus cloud is lower, and in thin sheets, like layers of fleecy cotton batting. Still lower is the cumulus cloud. Its base often rests on the earth. A snowy mountain of a cloud, the vapors climb up in rose and gold crested peaks and ranges, and shine in the sun.

*Do You  
Know a  
Rain Cloud?*

*How the  
Clouds Get  
Acquainted  
with Each  
Other*

# Summer Clouds



Cloud masses like this, looking like half-combed wool and not so billowy as the cumulus clouds, tell us of thunder showers to come. Some people call them "thunder heads." Ruskin calls them "rolling heaps."



Here's a billowy, beautiful, cumulus cloud. "Its base often rests on the earth. A snowy mountain of a cloud, the vapors climb up in rose and gold crested peaks and ranges, and shine in the sun."

Sometimes a shadow falls on the cumulus cloud. It turns gray. The gray spreads until the sky is covered with a shapeless, smoky vapor. That is the nimbus or rain cloud. The

rising vapor was like steam from a tea-kettle. It ran into a river of cold air that was coming down, turned into raindrops and fell. Clouds are always going up and coming down on air currents, and changing

from one kind to another. Most of the time they are mixed, part one kind, part another.

Twice a day the weather man

telegraphs a report to Washington, and to other central stations. From reports sent to him he makes a weather map, on an outline map of the United States. He can read

that weather map as easily as you can read this story. You can learn to read weather maps, too.

See the circles, or ring dots scattered over the map? A light circle about a clear, white space, means a

clear sky. Where there is a bar across the circle it was cloudy. If the rim is heavy the sky was covered with clouds. A black spot

**Cumulus Clouds Across the Sun**



Here cumulus clouds are covering the sun. Notice how the sun lights up and shines through the thinner parts of them. Cumulus clouds are truly "heap" clouds, as their name tells you.

marks where rain was falling. In the shaded places on the map a fraction of an inch of rain, or more, had fallen in twelve hours.

Of course you have guessed that the little arrows are weather vanes, showing which way the wind was blowing. The dotted lines that wriggle across the map show the temperature. Every place crossed by the same line had the same degree of heat or cold. The squirmy solid lines show the weight of the air, or air-pressure. There are several oval spaces inside air-pressure lines, marked "Low" and "High." Those are *very* important. They are the first thing a weather man looks at.

#### What a "Low" Is and What a "High" Is

A "Low" is an out door room full of warm, light air—that is, warm for the season. Warm air, you know, goes out of a room at the top of the window. Cold air comes in at the bottom, or through that crack under the door.

*Why Warm Air is "Polite"*

Warm air is polite. It goes out quietly. But cold air has bad manners. It pushes and elbows its way in like a bully on a playground. A "High" is full of cold air that is

coming down. It rushes down into a "Low" just as naturally as water runs down a hill; because it cannot help it. It is in a hurry. So a

#### Drifting Clouds



Watch a sky partly veiled with clouds as this one is. You will see the clouds driven onward by currents of air, some traveling rapidly, others drifting lazily along, but all of them constantly changing, assuming new shapes and forms.

"Low" for all it is so quiet, is a storm center. Blustering winds blow into it, catch the vapor and turn it into rain or snow. Weather changes come on the wind. But the wind doesn't really go "whither so-ever it

listeth," that is to say where it likes. The winds are "just naturally obleeged to go" certain ways—as the colored gentleman said.

#### Where and How the "Weather Crops" Grow

If you were to divide our country into weather zones you would probably make three broad belts running east and west. The northern edge would be cold, the southern warm, the middle "betwixt and between." But that way of dividing would not do at all for a weather prophet's work. Oceans and mountains, and the way the wind blows, have most to do with weather. We shall have to study our country to "understand its "weather crops."

The United States is three thousand miles wide, with an ocean on



the east and on the west. The sea coasts, mountain ranges and valleys all run north and south. But most of the winds come from the west.

*The Coast  
Rain  
Belt*

The winds that blow from the Pacific Ocean are stopped, two hundred miles inland, by the Sierra Nevada and Cascade Mountains. That makes a warm, rainy belt along the coast. This we might call "Weather Zone No. 1."

From the coast mountains to the Rockies is a high plateau, eight hundred miles wide, that never gets enough rain. It is cool and dry in the north, hot and dry in the south. The third belt is the eastern slope of the Rockies. Cold north, and hot south winds, with little moisture, blow there. Now watch these winds turn east! In the prairie belt, along the Mississippi, the winds are from the northwest and southwest. They pick up water from the Gulf and the Great Lakes, turn eastward and blow across the low Alleghenies, out into the Atlantic Ocean.

**Why the Wind is so "Fickle"**

"But," you may say, "where I live the wind blows every which way, sometimes all four ways in a day." Of course it does. You know the earth has two motions. It turns toward the sun, making day and night; and it travels around the sun, making the seasons. Wind travels

forward, in a straight or curved line, and, as it travels, it whirls. The winds *waltz* across the country, as dancers waltz across the room. You must have seen little whirlwinds waltzing along a dusty road. The wind that you feel, at any time, is only a small part of a wheel of wind that is moving forward. Cycle and circle mean the same thing. So cyclones are just circular winds. They may be a hundred yards or

*Gigantic  
Waltz of  
the Winds*

hundreds of miles wide. Cyclones are not dangerous unless they are traveling forward very fast, or spinning like a top. A wide cyclone, rushing like a railroad train, is a hurricane. A small cyclone, whirling so rapidly that it pulls up trees and houses, is a tornado.

**How the "High" and the "Low" Brought the Rain**

Let's see if we can understand that weather in Chicago that we spoke of at the beginning of these weather talks. With an east wind on Friday, bringing vapors from Lake Michigan, and a warm, hazy air, Chicago had a "Low." Wind arrows showed that colder air was flowing in from a "High" to the northwest. Another side of the big wheel of wind would pass over Chicago Saturday, giving a south wind. You see the weather man knew how fast the whole wheel was traveling southeastward. By

**The Mystery of the Little Wooden Horse**

What would you think of a toy horse that would take a walk—all by itself—just because the weather was bad?

It's a fact; there is a toy that does that!

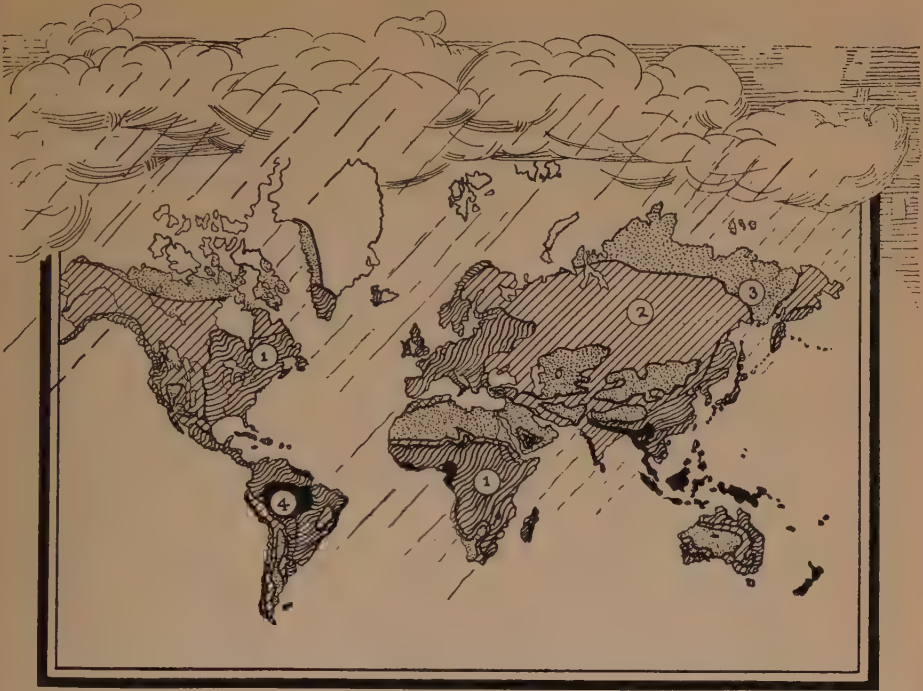
You shut it up in a room and lock the door and give the key—say, to your little cousin that is visiting you—and tell him to keep it until after the rain comes, and see if the horse has not taken a little walk.

Have him look the horse over carefully—take him apart if he wants to—and see that there is no machinery in him. Then, when he opens the door and finds the little horse has moved "quite a way," just as you said he would, show him (but let him guess a little first because it is good for boys and girls to guess about things worth while) that part of the horse is made of a pe-cu-li-ar kind of wood that expands in wet weather—grows longer; this makes the little horse push out his hind feet and so drive himself forward just as if he were galloping.

*On the  
"Other"  
Side of the  
Wheel*

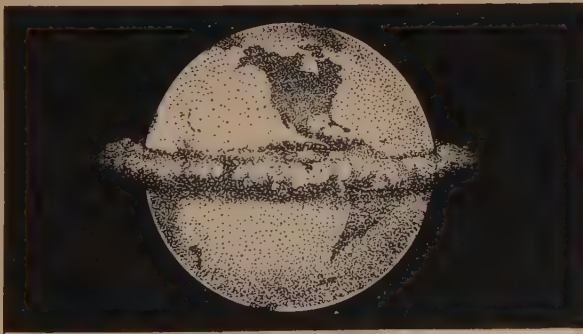
## THE WINDS AND THE WEATHER

### A Rain Map of the World



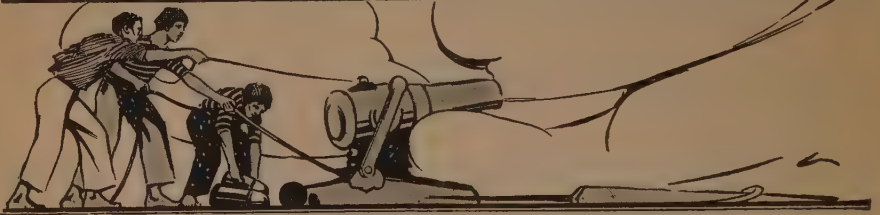
The parts with the heavy, wiggly lines, marked (1) have the average, good rainfall that is necessary for crop raising—from 20 to 75 inches a year. What zones are they in and how far are they from the sea? Number (2), the heavy, straight-lined parts of the world, have lighter rainfall, from 10 to 20 inches. If you know where the high mountains of the world are and from which direction the winds blow, it will be easy to explain the rainfall in these regions. In the parts of our own country covered by these lines, irrigation produces fine crops. The dotted areas are the desert lands with the least rain of all—less than 10 inches. The location of mountain ranges will explain them, too. And the black parts, number (4), are all near the equator, you see, where the rainfall is very heavy, over 75 inches a year.

### The Earth's Rain Belt



You have often seen pictures of Saturn with his rings. But did you know that if you could get far enough away from the earth to look back on it, as we do on Saturn through a telescope, you would see a belt of clouds around it? The water of the equator, under the hot sun, is constantly sending up vapor which turns to clouds in the cooler atmosphere of the upper regions and then comes down in rain. You never saw such a rainy place as it is around the equator.

# The War And The Weather Man



In order to predict the weather far in advance, it is necessary to know about weather conditions not only in the United States but in Europe; for we "import" weather from Europe just as we do other things. When the great European War of 1914 broke out, the United States Weather Bureau was receiving reports from all the places shown on this map and could foretell the weather a week in advance. When the war came, these Old World weather reports were cut off and the week-ahead predictions suspended.

Sunday night the farthest side of the cyclone, with cold northwest wind would pass over Chicago and turn the vapors to rain. Monday very likely would be colder and clearer.

The very worst of our storms are made by a "Low" in the Lake region, with a "High" in the northwest near the Rocky Mountains. A whirling torrent of cold air rushes down into the "Low," bringing wind, making rain and snow of the vapor in the air, and leaving cold behind it. Picking up

more water from the Lakes it sweeps far down the Mississippi and across the low mountains to the Atlantic ocean.

## The Storm Center in the Indies

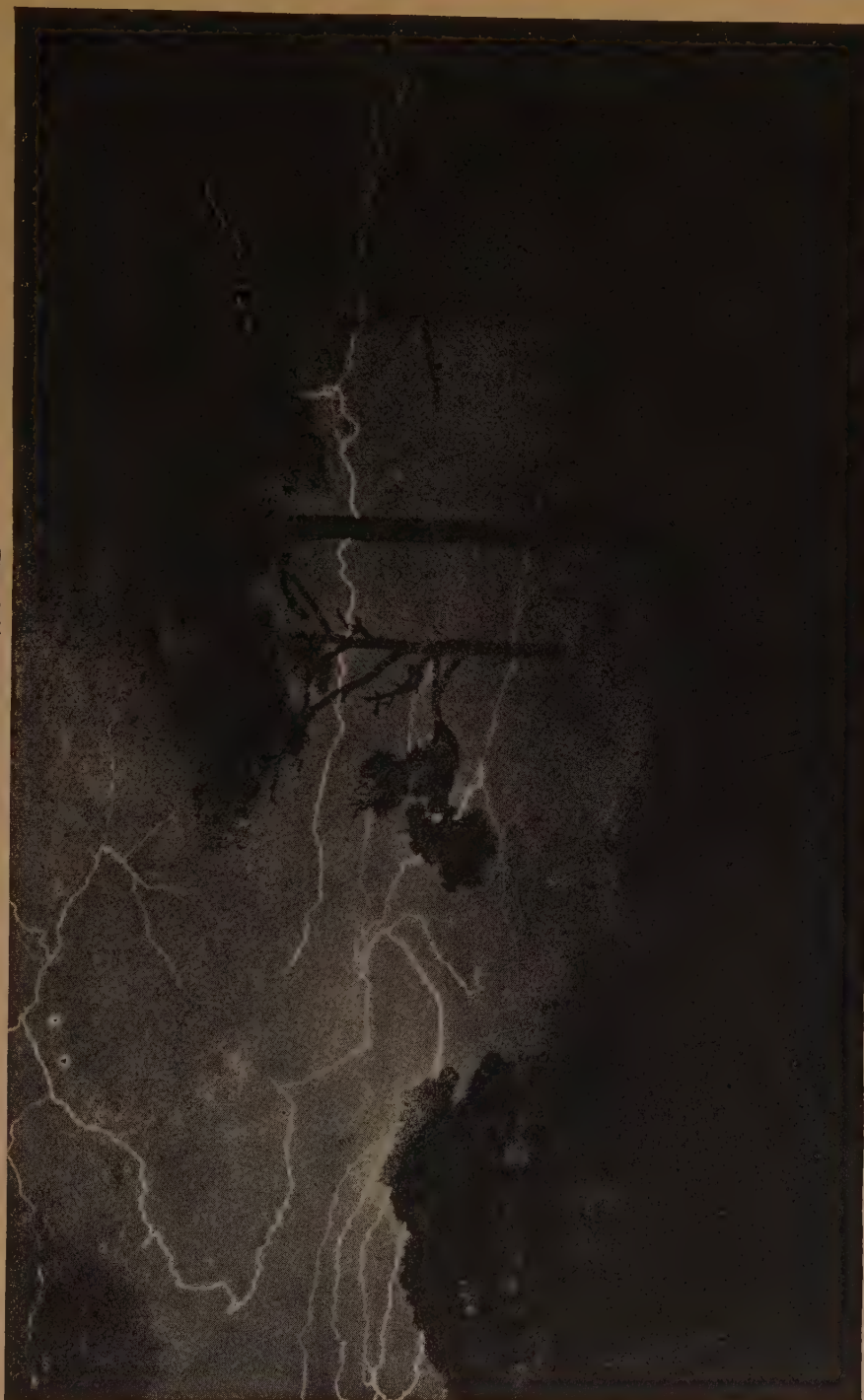
There is another storm center in the West India Islands, southeast of Florida. Hurricanes that start there sweep up the Atlantic coast, sometimes to New England, and curve out to sea. Or they turn westward and sweep the Gulf coast. Such a storm destroyed Galveston, Texas. But these West

*How Our  
"Nor'west-  
ers" are  
Made*

*Where Our  
Hurricanes  
Come From*



## Nature's Fireworks



No Fourth of July fireworks that man has invented can equal the fearful beauty of lightning. See how graceful and delicate its branched forks are. The flash lasts only one hundred-thousandth of a second.

Indian storms never cross the Allegheny Mountains, nor come very far up the Mississippi valley. That big west wind, that crosses the lakes and spreads south and east, pushes the other wind away.

"Get off the track!" it says. "I'm the through train and have the right of way."

The Indians called the west wind "Mudjekeewis, king of all the winds of heaven."

#### The Old Joke About Medicine Hat

There used to be a joke about a place in Canada called Medicine Hat. People said it was not a town but a "weather factory." Now, we know that Medicine Hat gets its weather from the west, too. So does the Pacific coast. The wind blows eastward across the Pacific, and eastward across China and Siberia. The Russians used to think their weather factory was in Norway. English people thought their weather was made in the Atlantic Ocean. Now they are sure it comes from Labrador. New York blames Chicago for its blizzards. The Chicago weather man keeps *his* eye on the northwest.

Do you see? There is a wide cyclone path around the earth, between latitudes forty and sixty, north; just where most white people live and travel and trade. All the

storms over that wide path blow from west to east. Where these winds blow over bodies of water *Warm and Rainy,* they are warmed, over *Cold and Dry* land they are cooled. So, the northwestern coasts of both the old world and the new are warm and rainy, the northeastern coasts, cold and dry.

#### The Watch for Cold Waves

All the way around the northern world, weather men keep their eyes chiefly on the west and watch the "Lows" and "Highs." If there is

a "Low" at Chicago and a "High" one thousand miles to the northwest, and the wind is traveling forty miles an hour, the weather man will say a storm is coming and should be here in about twenty-four hours, followed by a cold wave.

But, if there

is another "Low" in upper Michigan, that storm may turn east over Lake Superior.

In that case Chicago might get the southern edge of the cyclone, and have local showers. On the high plains east of the Rocky Mountains rain is most apt to fall when north and south winds run into each other. But in nearly every other part of the country it is the meeting of the east and west winds that most often brings the rain pouring down.

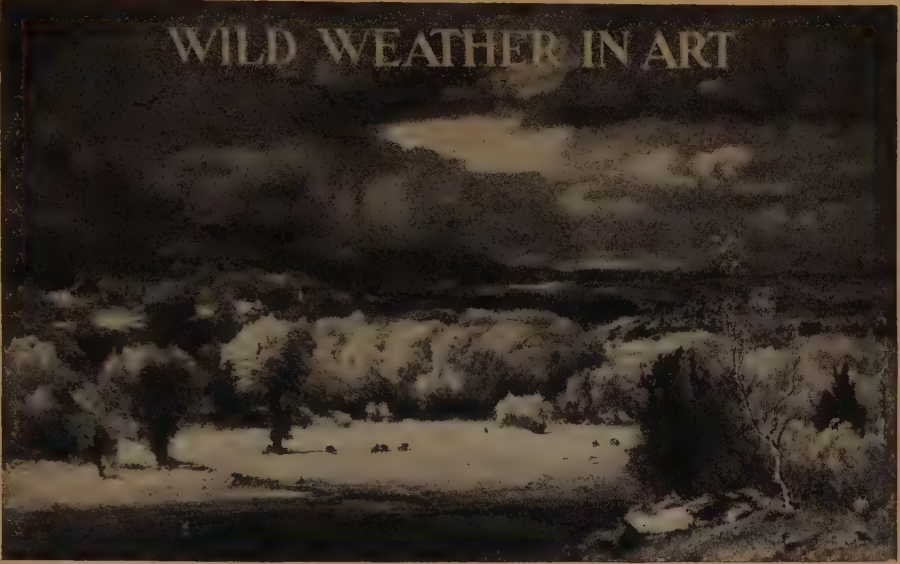
#### BEETHOVEN'S STORM SYMPHONIES

Henry Ward Beecher.

"The seventy-third psalm reminds me of some of Beethoven's Symphonies; and *these*, again, always make me think of the tumult of the forest, when the wind roars and swells and surges with wild discord among the trees; when the branches creak and crash against each other, and every bough has a separate wail. By and by the wind lulls; and when twilight is beneath, and all the forest is quiet, or only so much noise as the insects make it, then some bird on a treetop sings out clear and sweet, and his song goes floating away over the wood, the very soul of peaceful joy."

*Rocky  
Mountain  
Weather*

## WILD WEATHER IN ART



© Detroit Publishing Co.

### **The Coming Storm, by George Inness. (American, b. 1825)**

The work of Inness stands in American art where that of Rousseau and Corot does in France. He was a landscape poet. How wonderfully he tells us here of the storm laden atmosphere, the "rolling heaps" and "wild gathering of thunderclouds with their solemn hush before the tempest breaks."



© Taber-Prang Art Publishing Co., Springfield, Mass.

### **Beethoven Listening to the Storm, by M. Wulff. (German)**

Now the storm breaks. As Inness put the poetry of nature on canvas, so Beethoven told of its grandeur in his music. The great word painter, Henry Ward Beecher, has translated both the music and the storm for us into words on the opposite page.



Live Weather Vanes



Did you ever see a weather-vane perched 'way up on a farmer's barn to show which way the wind is blowing? Let's pretend we're weather-vanes! Take a deep breath, stretch your arms out straight at the sides, and blow out your breath as you twist from left to right and back again.

"Making Hay While the Sun Shines"



"Before the Storm" was painted by Julien Dupre, a noted French artist. It shows some peasants hurrying to get their hay "in" before the black clouds drop their load of rain.

### What the Weather Did to Mr. Sphinx' Nose



This picture illustrates what is called "weathering," that is to say, how the weather with its winds and its rain and its frost and flying sand shapes the rocks and the mountain tops. It even carries off people's noses—piece by piece; particularly if these noses are carved in stone, as was that of the solemn old Mr. Sphinx. The Sphinx is one of the oldest pieces of sculpture in the world and has been weathered by the winds and sands of Egypt for centuries and centuries.

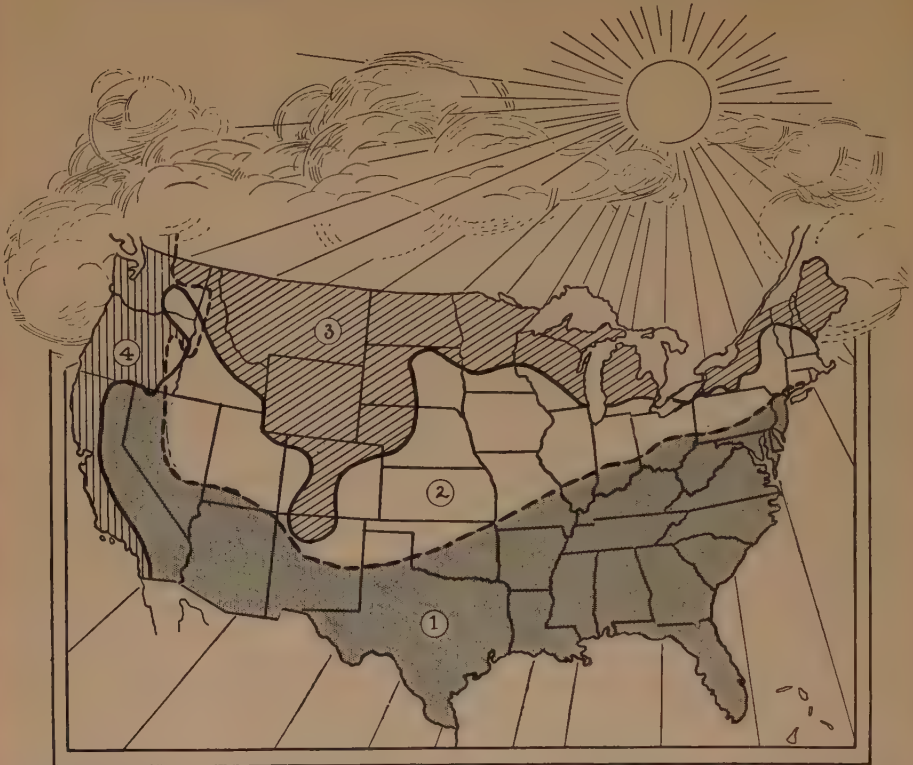
### The Three Brothers and the Great Stone Face



On the left of the lower picture are the Three Brothers, mountain peaks in Yosemite Park. On the right is the Great Stone Face about which Hawthorne wrote you that beautiful story. Most of these strange forms are found in dry regions. They are carved in the rocks by the wind and flying sand, which cut away the softer rock and leave the harder rocks outstanding. In the desert regions of India, for example, there is a figure carved so that it looks for all the world like a tiger crouched on the edge of a big boulder.



## Four Kinds of Climate in the United States



Our country can be roughly divided into four areas, each of which has the same general conditions of climate. The area indicated by (1) is composed of the states farthest south. You know what the weather is there—the summers are hot and the winters temperate. North of it is the white space on the map, region number (2). In it we find the two extremes of temperature, cold winters and hot summers. Number (3) has moderate summers and cold winters, and number (4), the Pacific coastal region, is always temperate. Its summers are not very hot nor its winters very cold. A present that the sea brings us from Japan is responsible for the moderate weather near the Pacific. Do you know what it is?

“What good does it do to know what kind of weather is coming?” you ask. “No one can stop it, or do anything about it.” Well, let’s see. Storms on the lakes and seas are dangerous for ships. When the weather man puts out a black or a red centered flag, giving warning of a “cold wave,” or “high wind and snow,” captains keep their vessels in port. When a farmer sees a blue flag, or a blue and white one, on the weather bulletin in the postoffice, he knows he must hurry home and get in the hay, before the

coming “rain,” or “local showers” can spoil it.

When frost is pre-dict’-ed orange growers watch thermometers in their orchards, and keep oil stoves burning under the trees to raise the temperature. Shippers hold back eggs and fruit in zero weather. When warned of a blizzard, railroads get out their snow plows to keep the tracks clear. The price of wheat and cotton go up and down, on good and bad weather reports. Public health officers watch weather, and warn people when there are likely to be more cases of scarlet

*What the  
Weather  
Prophet  
Does for Us*

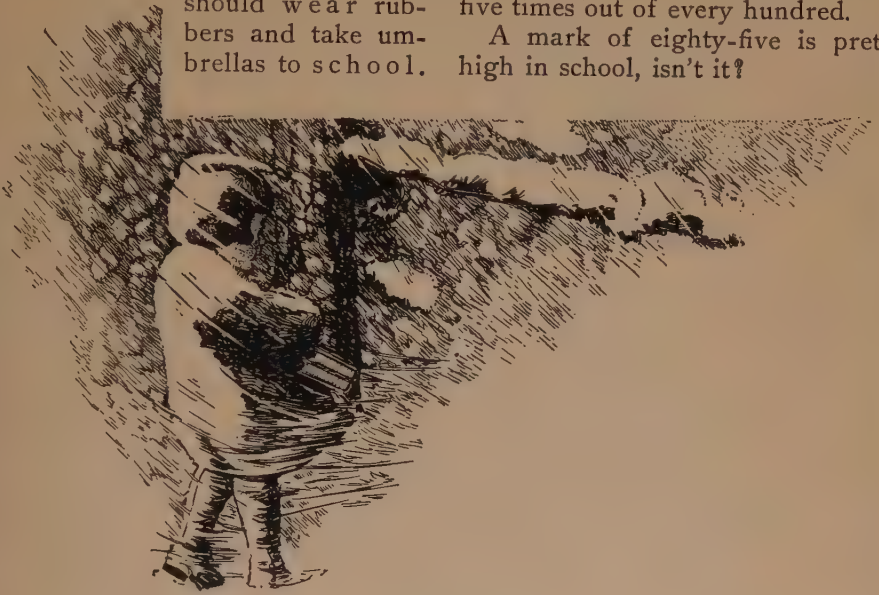


fever, diphtheria, pneumonia and grippe. Every paper prints what the weather man says, and sensible people obey his orders.

When the weather man says it is going to rain or snow, children should wear rubbers and take umbrellas to school.

And they should ask him if they can go nutting in the woods, or have a picnic tomorrow. Sometimes a storm runs off on a branch line, or backs up on a switch and fools the weather man. But he is right, eighty-five times out of every hundred.

A mark of eighty-five is pretty high in school, isn't it?



## When the Winter is Over

*And when the winter is over,  
The boughs will get new leaves,  
The quail come back to the clover,  
And the swallow back to the eaves.*

*The robin will wear on his bosom  
A vest that is bright and new,  
And the loveliest wayside blossom  
Will shine with the sun and dew.*

*There must be rough, cold weather,  
And winds and rains so wild;  
Not all good things together  
Come to us here, my child.*

*So, when some dear joy loses  
Its beauteous summer glow,  
Think how the roots of the roses  
Are kept alive in the snow.*

ALICE CARY

## NATURE STUDY AND THE CHILD



**H**AT is the use of Nature Study? It is the mother and teacher who ask that, never the child. To him a nature book is a thing of wonder. Like magic it summons up things new and beautiful and strange from far and near. The pictures and the description of the book are almost as real as reality. The child's imagination is not only wonderfully vivid, but he lives, much of the time, in his imagination. To him imagination is the hand-maiden of knowledge. Through it he learns to see, to observe, to find the wonderful in the commonplace. He learns to "spend his five senses" to good purpose.

Do we not all feel that a blind or deaf child is pitifully handicapped? There is a whole world of things he can never know or do. But do we realize that they are only a little less handicapped, whose senses are untrained—who, having eyes, see not? The most successful people are those who see, hear and feel the most, who grasp ideas and situations most quickly and reason the most logically.

It is a mistake to think that the senses train themselves. With the years they tend to become duller, and used below their capacity they never develop to their full powers. They are keenest in childhood at the very time when curiosity is liveliest. Curiosity, properly directed, leads to interest, interest to attention, and attention to observation. And here, at our doors, is the abundant material that has educated the race. In the book of nature is to be found all the color, form, texture, sound, odor, motion, economy, cold logic and warm emotion that have been put into the world.

### Importance of Method

Just what things he observes or how many, is of less importance than how. In the subjects treated here, we have chosen those of universal interest and importance in themselves, and have used these studies to illustrate the educational viewpoint and the best methods of teaching. There is a story in a pebble or a snowflake, but as a rule, living things attract children most. The little drama of existence unfolds under the wide eyes of wonder and sympathy. And eager absorption opens all the gates of knowledge and develops new powers of thought and action. And then, suddenly the child discovers the use of books—this book. He comes to it, not to an assigned lesson, but to find out something he wants to know. And do not be troubled if he is backward in his speech and writing. When he really knows something, from observation and reading, he will talk and write about it with feeling and intelligence.

### Quench Not the Spirit

But, in emphasizing the importance of method and the training of the senses in Nature Study, we must not forget that the eyes are only the windows of the soul. Nature Study means most if we learn through it to love Nature more and more. Pursuing the work in this spirit, we may all come to say with Burroughs: "Mine have all been contented and happy years. I am certain that my greatest source of happiness has been my love of Nature."





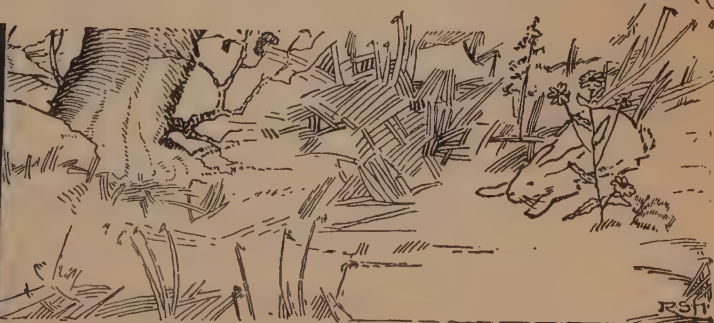
A Letter from John Burroughs  
To Our Boys and Girls

West Park N.Y.  
April 9.

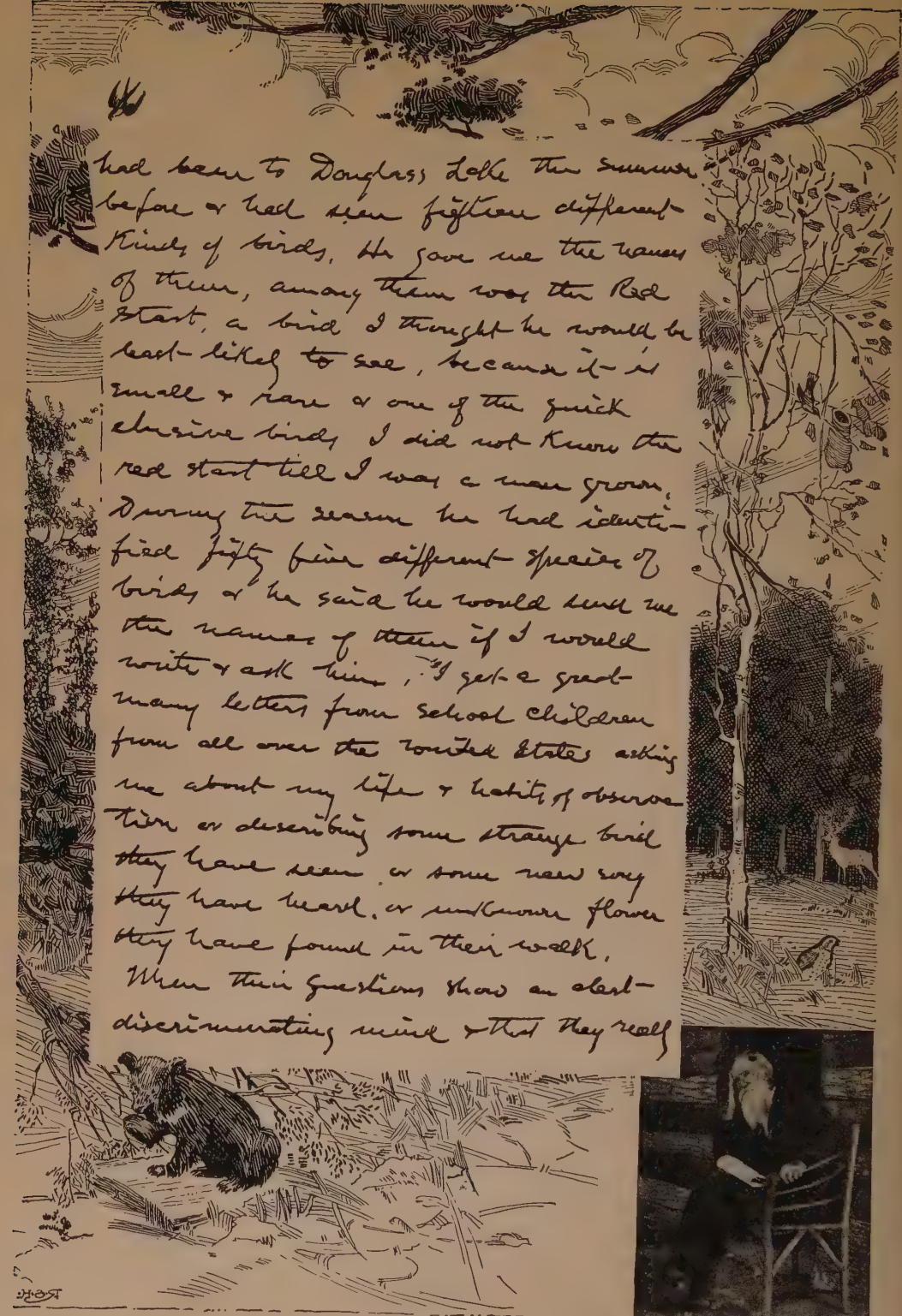
To our Boys & Girls,

My Dear Young Friends,

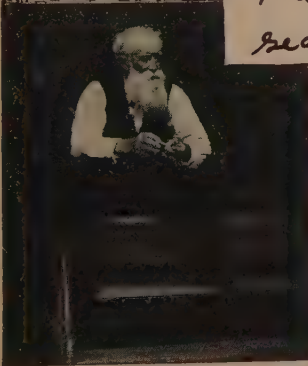
The other day I had a letter from a little boy in Michigan who said, among other things, that he wanted to be a naturalist like myself. I told him it was the easiest thing in the world to be a naturalist like myself if he lived in the country & loved nature as I did. He might be a much better naturalist because he had begun earlier than I did & he lived in a time when there was more help on every hand than I found — in school, in clubs, in papers, in magazines &c. I was a farm boy & never had any nature literature in my hands, till I was a young man. My young correspondent



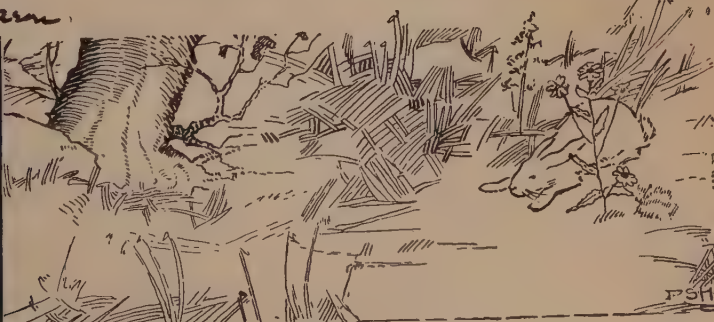




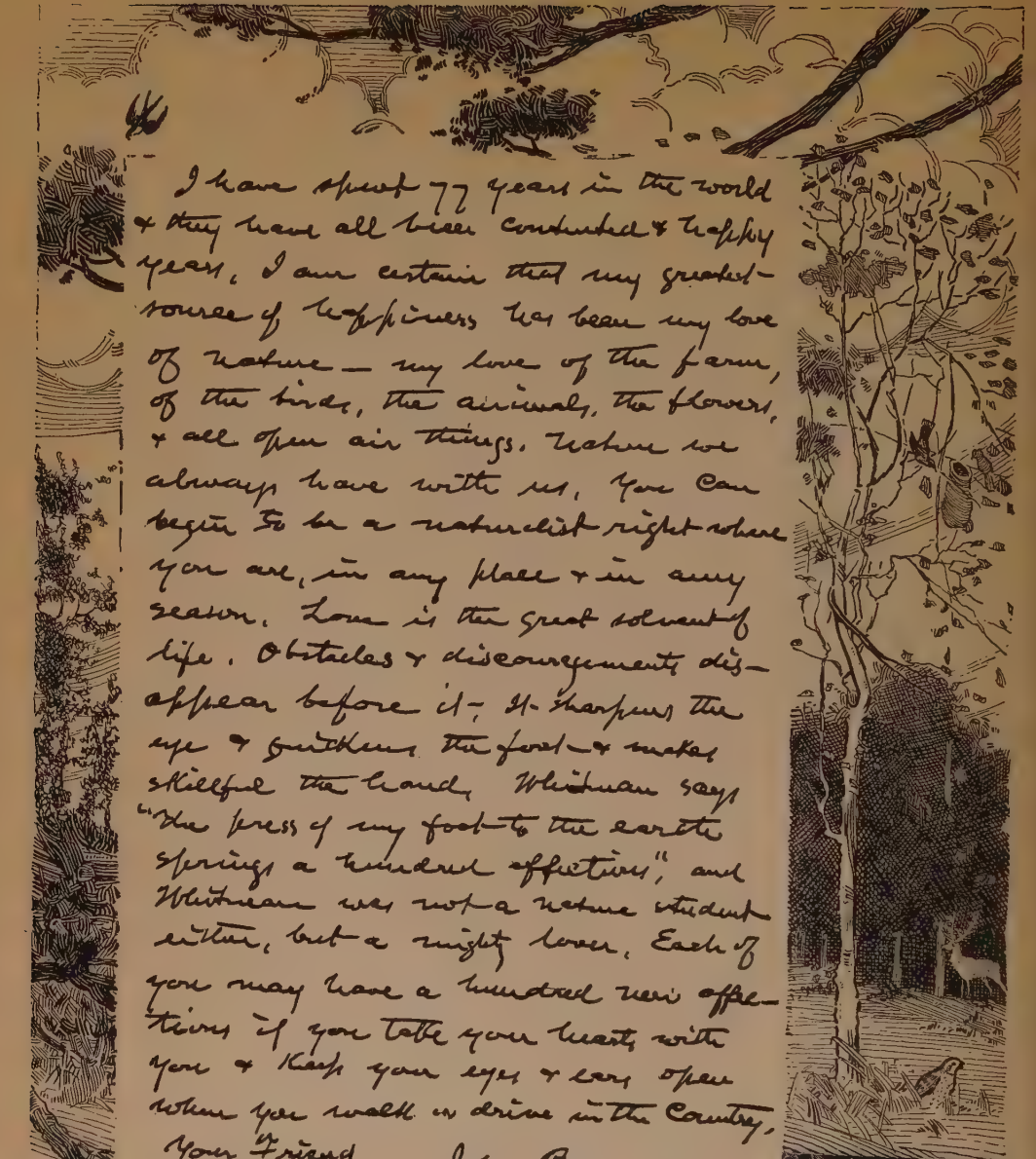
had been to Douglass Lake the summer before & had seen fifteen different kinds of birds. He gave me the names of them, among them was the Red Start, a bird I thought he would be least-likely to see, because it is small & rare & one of the quick elusive birds. I did not know the red start till I was a man grown. During the season he had identified fifty five different species of birds & he said he would send me the names of them if I would write & ask him. I got a great many letters from school children from all over the United States asking me about my life & habits of observation or describing some strange bird they have seen, or some new way they have heard, or unknown flowers they have found in their walk. When their questions show an alert-discriminating mind & that they really



want information & not merely my  
autograph. I usually answer them,  
Sometimes all the pupils of one of the  
higher grades, who have been reading  
some of my books write me, & fill  
a big envelope with their letters.  
They tell me of their own observations  
in field & woods, or about house & often  
show great keenness & quickness of  
eye & ear. Their letters often contain  
interesting bits of live natural history,  
Where you have once become inter-  
ested in the wild life about you  
a walk in the country will mean  
so much more to you. You will  
find news from far climes, or  
novelties in the home fields every  
day. The book of nature is a book  
you can never read through. A  
fresh page is added every morning  
& a new edition comes out every  
season.







I have spent 77 years in the world  
 & they have all been consumed & trifling  
 years. I am certain that my greatest-  
 source of happiness has been my love  
 of nature — my love of the farm,  
 of the birds, the animals, the flowers,  
 & all open air things. Nature we  
 always have with us. You can  
 begin to be a naturalist right where  
 you are, in any place & in any  
 season. Love is the great solvent of  
 life. Obstacles & discouragements dis-  
 appear before it. It sharpens the  
 eye & quickens the foot & makes  
 skillful the hand. Whitman says  
 "the press of my foot to the earth  
 springs a hundred affections", and  
 Whitman was not a nature student  
 either, but a mighty lover. Each of  
 you may have a hundred new affec-  
 tions if you take your hearts with  
 you & keep your eyes & ears open  
 when you walk or drive in the country.  
 Your friend John Burroughs





# IN THE GREAT WORLD OF NATURE THE GREAT GRASS FAMILY

## Wonders You Can Find In The Grasses



**I**SN'T it funny to see grand-papa look for his spectacles when they are on his nose? But there is a still better joke on the little and big people who never see things that are right under *their* noses. Once a

famous college professor told a class of young men to study the things we live fish in a tank. It was a week before any student thought to mention that those fish had scales, and of many kinds.

### The Velvet Carpet on the Lawn

Let's go out and study grass together. Pull up some grass on

the edge of a lawn. It will not come up in a bunch. The roots *Going Down* will part raggedly. *Where the Grass Begins* They are really buried stems or runners, spreading underground. Green blades spring up from the joints, and root-hairs go down. Most grasses grow in tufts or knots. Blue-grass and other creeping grasses make the best covering for lawns. The buried stems mat together, making a springy turf.

All grasses are soil binders. In dry weather they keep the earth from cracking and soil from blowing away in dust. In wet weather they keep the soil from being washed away. On grassless deserts wind-blown sands fill in every road that men make, and have buried temples and cities. Grass is bed-clothes tucked about the root feet of trees, shrubs and flowers, keeping them from being sunburned and frost bitten.

If these were the only things it did, grass would be very useful. But it is also the chief food of

*How Grass "Sews" the Earth Together*

*Things We Look At but Do Not "See"*



the most useful family of animals—the grazers. Bossy cow eats grass to run her milk and butter factory. Horses, sheep, goats, elephants, camels, buffaloes, deer and kangaroos are grass eaters.

Once they get above ground all grasses grow alike. They have jointed stems. Between the solid ring-joints the stems are nearly always hollow tubes or straws. What plants can you think of that have jointed, straw stems?

Wheat, oats, rye, barley, rice. The bread grains of the world, and the grains eaten by animals are the ripened seeds of a small group of grasses called cereals. Yes, corn-bread, too. Corn has a jointed stalk filled with a softer pith. Sugar cane is another tall grass. Fishing poles are made from bamboo, a giant grass. Canes with solid joints and hollow stems, as big as trees, spring one hundred feet in the air. The Filipinos and other tropical people build bamboo houses, bridges and stairs, and make furniture, baskets, umbrella frames and countless useful things of bamboo.

#### Did the Fairies Use These Cups?

By cutting across a solid joint, then a little higher on the stem, they make good water pails and drinking cups. You can make a cup from the tiniest grass stem. It would hold a dew-drop for a fairy.

The leaf of every kind of grass is a tapering ribbon, with parallel veins. The base of the leaf grows from a joint, entirely around the stem. Each leaf grows alone, one from each joint, in a spiral stairway around the stem.





## A Strange Member of the Grass Family



This is one of the ways in which "grass" grows in Australia. It sometimes reaches a height of 30 feet and is called "the drumstick grass tree." See the drumsticks? These grass trees are survivals of an age when rushes and sedges grew to an enormous size. They are one of the numerous queer things you find in Australia.



Did you ever cut your finger on the sharp edge of a blade of grass? The grasses use silica, or glass, in their bones, to help them stand up, as we use lime. Some grass blades are knives and some are toothed saws. Put them under a microscope and see the edges sparkle. It is the silica that makes wheat straws and corn stalks so smooth and bright.

### The Flowers of the Grasses

What a mistake to think that grass has no flowers. Any blue-grass lawn, uncut for a few weeks, shows a feathery forest of flower heads. Each one is a loose many-branched pyramid like a pygmy pine tree. Some grasses bear their flowers on drooping plumes; others in stiff, crowded spikes, like scratchy pussy willows. The flower head may be any shade of green, a silvery gray or brown, yellow, red or purple. You might not notice the color of one, but a field of any variety, like red-top, has a distinct color. When ripe, many of the grasses turn gold. A golden wheat, oats or rye field is a beautiful sight.

A dozen blue-grass blossoms could camp out comfortably on a pinhead. Spear one with a fine needle, and put it under a magnifying glass. The flower cup is imperfect, just scaly shields, but there are three little pollen hairs, and a hollow tube for the pollen to fall down to the seed case—just as in the bell

of the lily. The lily is a three-parted flower, with six petals. And it, too, has ribbon-like leaves. Lilies and grasses are near relations. But grass has so little perfume that it has no insect visitors. Wind scatters its pollen. Such a lot of it! One blossom of rye makes 20,000 grains.

Most of the grasses have the pollen hairs and the egg case in the



A Bamboo Grove

same blossom. But Indian corn has two kinds of flowers on one stalk. The handsome spiked tassel at the top is the pollen maker. The seeds are on the "ear" of corn that grows from a leaf axil. The wind blows the tassel, shaking the powder down on the "silks." The pollen grains just "scoot" down the hollow silks

to the seeds crowded on the cob.

Of all the grasses it is easiest to study corn, because every part of it is so large. There, the whole cob full of seeds is wrapped in husks. But in wheat, and most other grasses, each tiny seed is wrapped up by itself, in straw scales. When the grains are threshed these scales fly away as "chaff." Some seed scales have bristles, that make stiff beards, on the crowded seed spikes. Barley, rye and some wheats are bearded.

All the grasses bear a one-leaved seed. The baby plant grows from one side. Peas and beans split into two leaves. Corn and wheat do not. Plant these seeds in sand boxes and see how differently they grow. Wheat looks as though it might split in growing, because of the groove in one side. Many grass seeds have that tiny furrow.

The cereal grains are little lunch boxes, filled with food for the baby plant. First there is a horny skin on wheat as thin and as tight as your skin. Then there is a layer of brown gluten cells. The middle is a plump pocket full of white starch.

#### Nearly a Thousand Things To Look For

And grass is all alike? Why there are nearly one thousand varieties in our country alone! Along every roadside you can find dozens of them. All the grains but wheat grow wild. You can find the large, drooping seed sprays of wild oats, the bristling beards of wild rye and barley. Some of the wild grasses looks so much like the field grains that farmers call them "cheats."

Wild rice is often called the reed grass. It grows in the shallow water of marshes around our northern lakes and southern sea shores. It



#### Cultivated Wheat

Wheat is supposed to have first come from Asia. If you knew the history of wheat, you would know almost the history of civilization, for it has been used as food since the beginning of history. Some kinds of wheat have white grains and some are red, but it gets its name from an old Anglo-Saxon word, "hwaete," which means white.

Another curious thing about wheat is that some varieties wear a "beard," while others are "bald-headed." An old Persian poet speaks of "harvesting the bearded grain."



Timothy

has two kinds of flowers, a bearded, pollen-making stalk and drooping seed sprays. A wild rice marsh, threaded with rivulets, is always full of ducks and bobolinks and hungry fish, feeding on the falling grain. Indians used to paddle through and beat the grain off into their canoes.

Blue grass is kept cut close on lawns for the velvet turf, but in a pasture its blossom heads spring three feet high and silver bright. Redtop, too, has a pyramid flower head, but of a purplish red. Timothy is the best of the hay-making grasses for winter feeding. Its flowers grow in crowded cylinders as round as a lead pencil, often six inches long, and glisten as with dew. He is a contented farmer who in the fall, has a haymow full of well dried timothy and clover. Orchard grass grows best in the shade. It grows in tufts of blue-green leaves, with its flowers in a drooping, graceful plume of one-sided clusters.

Like every other kind of plant, grasses are both wild and tame. Many grasses, as we have just seen, grow by waysides. Old witch grass sends up a plummy spray of seedy threads as from a vase. Red and brown and yellow foxtails switch their bristling spikes. Wire, crab and finger grasses grow spiky clusters like corn stalks. The cockspurs and burr grasses catch at the garments of every passer-by. Wayside, sedge, marsh, dry and wet woods, sand dune and beach each has



Burr Grass



## The Travelers' Tree



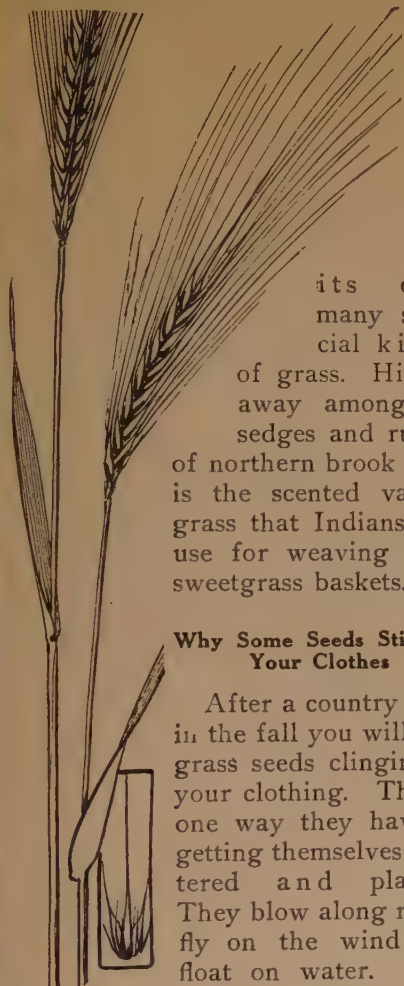
It looks like a giant palm-leaf fan considerably the worse for wear, doesn't it? These palm-like trees grow in the Island of Madagascar. The lower parts of the huge leaf stalks are hollow, so that they catch a large quantity of water. If the leaf stalk is cut across, a stream of water gushes out to refresh the traveler; so you see how it got its name.



Red Top



Indian Rice



Cultivated  
Barley

its own many special kinds of grass. Hidden away among the sedges and rushes of northern brook sides is the scented vanilla grass that Indians still use for weaving their sweetgrass baskets.

#### Why Some Seeds Stick to Your Clothes

After a country walk in the fall you will find grass seeds clinging to your clothing. That is one way they have of getting themselves scattered and planted. They blow along roads, fly on the wind and float on water. Most of them have scales and hooks to cling by. Some become sticky or gummy, when wet.

Some remain on the seed sprays, become entangled with others, and are tumbled across country by the wind, as are many tumble weeds and thistles. When they find a bit of soft, damp earth they sink into the ground. With their sharp pointed, twisted bristles the seeds of wild oats *bore* into the ground as though they were live gimlets!

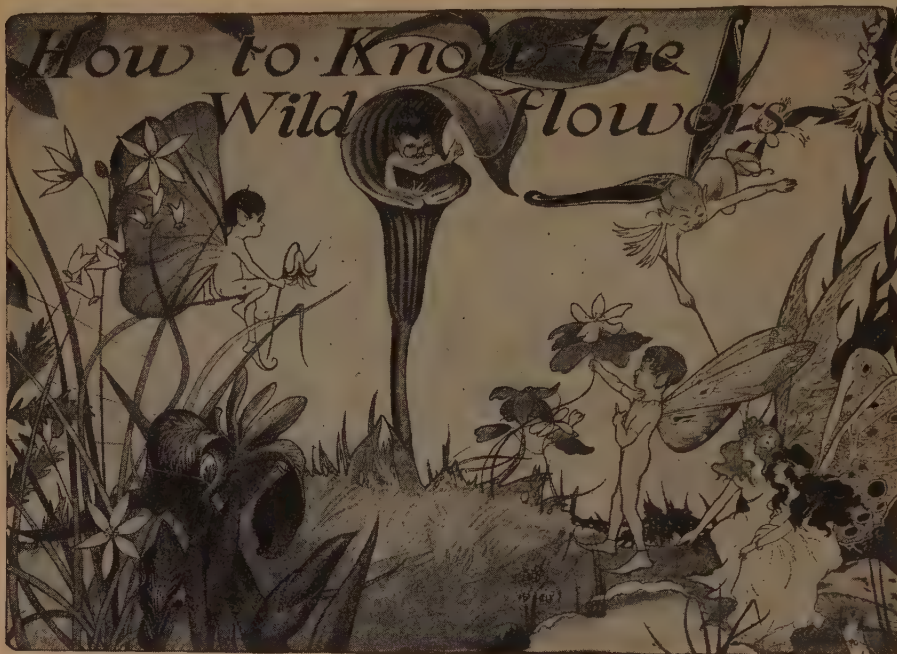
In one of the loveliest of the old Greek stories, wheat was a beautiful maiden, Per-seph-o-ne. With the coming of the winter cold, she went down into the earth to live with Pluto, the grim old god of the Underworld. All winter her weeping mother, Cé-res, looked for her lost daughter with a lantern. At last the maiden appeared as a tender green mist, veiling the earth. Then she danced out, into the golden sunlight, and trailed her emerald robe across the land. All summer the happy Ceres toiled in the fields to make the grains fruitful. So all our bread grasses are called "cereals."

It would take a big book to tell you everything there is to know about grasses. We have left a great deal for you to find out for yourselves for that is the best way, after all. You could make some impressions of grasses on blue print paper and fill an album with them. You could take hundreds of these pictures, and no two would be alike.





# IN THE GREAT WORLD OF NATURE WILD FLOWERS



WHERE to begin to learn about the wild flowers is a puzzle. It would be nicest of all to begin by running right into a wood or field, "tossed full o' blossoms, leaves and birds."

But we have such a big country, with so many kinds of climate. In most parts of it little green points push up in March, and run across the earth like flickers of emerald fire. By April they kick off winter wrappings and toddle out into the sunshine and showers. Before

*The  
Geography of  
Our Flowers*

May the first delicate blossoms have opened. But in New England, as Lowell says: "Half our May's so awfully like Mayn't," that many spring

flowers are delayed until June. On the Gulf Coast, where frost is rare, and in California, where rainy winter is the growing season, some flowers are in bloom at Christmas, and May comes in February.

Cold north, sunny south, sea-coast, forest, prairie, mountain, dry plateau, each has its darling flowers unknown elsewhere. You should learn to know the favorite flowers that grow wild nearly everywhere. They bloom at different times and vary in size and color but are always to be found in much the same places, in wood, pasture, wet banks or shallow water. We will try, this time, to get acquainted with just

## The Snow-White Bloodroot



"You may see a whole colony of snowy, gold-centered stars of the bloodroot. This has pointed, satin petals and the blossom is shielded by a deeply lobed leaf that springs on its own stem from the root. The bloodroot is the Indian paint flower—an orange-red juice oozes from the broken stem."

those sweet-smelly, or very beautiful or odd looking ones that are nice to put in vases for bouquets.

#### Flower Fairies Come First to the Woods

The very first flowers of the year, everywhere, are in the woods. After the tree blossoms have fallen, and often on snow patches, leafless shrubs, under the new-leafed canopies, suddenly burst into mists of bloom. The spice-bush with its tight little bunches of clove-scented, lemon-colored blossoms, and the blushing red-bud with its crowded, knobby flowers always look like the flowering sprays painted on Japanese screens. Later the large dogwood blossoms make snowdrifts in the forest aisles. Then the wild crabapple is a thorny, twisty bouquet of apple bloom, and the big hawthorn is hung all over with snowball bunches.

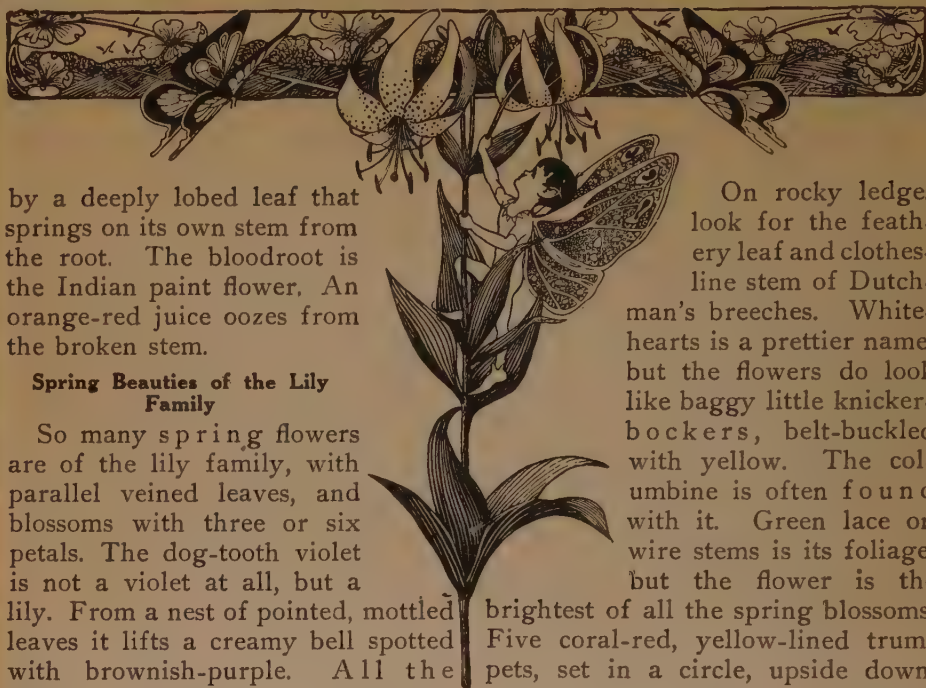
On the ground few of the earliest bloomers stand more than six inches high. The blossoms are small and pale—for it takes a hot sun to burn

*Why Earliest  
Flowers  
Are Pale*

bright colors into flowers—and the leaves are thin and sketchy as if there was no material to waste. To pick these delicate, short-stemmed flowers you should have a basket lined with wet moss or leaves, to lay them on, for they wilt in hot hands, and die before you can put their little stem feet in water.

Some flower lovers say the hepatica comes first. It looks like a flowering moss. White, or faint blue blossoms, with from six to twelve rounded petals crown the short, hairy stems. But before you find that, you may see a whole colony of snowy, gold-centered stars of the bloodroot. This has pointed, satin petals, and the blossom is shielded





by a deeply lobed leaf that springs on its own stem from the root. The bloodroot is the Indian paint flower. An orange-red juice oozes from the broken stem.

#### Spring Beauties of the Lily Family

So many spring flowers are of the lily family, with parallel veined leaves, and blossoms with three or six petals. The dog-tooth violet is not a violet at all, but a lily. From a nest of pointed, mottled leaves it lifts a creamy bell spotted with brownish-purple. All the trilliums, or wake-robins, are lilies. A wiry stem supports three, broad leaves in a flat whorl. From where *A "Violet"* they are joined a flower rises. Both the white and the painted trilliums flare open and flutter three pointed petals. The stemless wake-robin is closed into a stiff purple-red cone.

Later in the season you should look for Jack-in-the-pulpit. The flower is a club spike standing in a bell, like the calla lily. This sheath is a leaf of green and purple, the tip arching gracefully over the little preacher. Another lily, most beautiful for its foliage, is Solomon's Seal or twin flower. It is a swaying fern-like leaf of many leaflets. Strung along the stem are pairs of small closed bells of greenish white. As many as ten pairs of twins sometimes droop from one twelve-inch leaf.

*Jack-in-the-Pulpit and His Friends*

On rocky ledges look for the feathery leaf and clothes-line stem of Dutchman's breeches. White-hearts is a prettier name, but the flowers do look like baggy little knickerbockers, belt-buckled with yellow. The columbine is often found with it. Green lace on wire stems is its foliage, but the flower is the

brightest of all the spring blossoms. Five coral-red, yellow-lined trumpets, set in a circle, upside down, spurred at the base, and flaring at the mouth, make a neat cylinder blossom an inch or more long and across.

Anemones, or wind-flowers, grow in colonies on clean grassy openings in the woods. Each plant is a wire stem supporting a whorl of feathery leaves. Above that a five-petaled rosette, pink or pearl white, flutters in every breeze. Bloodroots grow among them, and the pink striped star of the spring beauty. This nods from a fleshy pink stem and has thick, grassy leaves. Like many wild flowers, it shuts its eye at sunset, and when broken from the stem. But it revives in water. Its glistening little face looks newly rain washed.

#### Sweet Miss Violet and Her Neighbors

The buttercup looks wet, too. If you hold a blossom under the chin it reflects a yellow spot. It is found as early as May, and continues



## The Shy Little Blue Violet



"The dewy blossom is half hidden, and the face is tipped over, shyly, on a bent stem. Blue, delicately marked, gold-hearted, sweet-scented, the violets carpet the banks, meadows and swamps."

blooming nearly all summer. The golden cup of five, rounded petals is an inch across. The leaf is much like a deeply cleft maple. The marsh marigold is often mistaken for the buttercup. But that grows in swampy places, the blossom is larger and the leaf heart shaped. Violets

*How the Violet Hides in Its Nest* are almost sure to be found near buttercups.

If you do not know the violet leaf you may find none of these darling flowers. Most of them, before blooming, grow nests of glossy, heart-shaped leaves. The dewy blossom is half hidden, and the face is tipped over, shyly, on a bent stem. Three petals stand up, two hang down, and underneath is a spur. Blue, lavender, purple, yellow and white, delicately marked, gold-hearted, sweet-scented, the violets carpet the banks, meadows and swamps. One kind lifts a branching flower stem above a bird's-foot leaf.

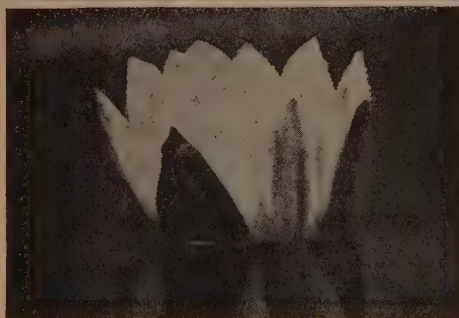
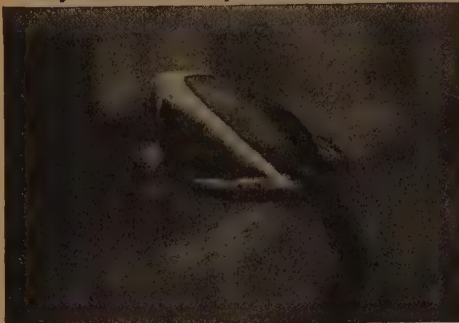
Each little dewy face somehow looks different. You want to kiss all of them.

Coarser and taller than the earliest blossoms, the wild geranium and the ox-eye daisy herald the coming of summer. The first has a lavender-pink geranium flower and five-parted, downy leaves. *And Flowers Play Truant, Too!* The daisy, or white-weed, blooms from May

to November by every wayside. Around a yellow button is a wheel of many strap-shaped rays. Brought over from England as a garden flower, the daisy escaped, and now grows wild.

The prettiest thing to put with the daisy is another run-away—the forget-me-not. This golden-eyed tiny blue flower grows in clusters on half-running stems, along wet brook sides. If you cannot find them use blue-eyed grass. It is not a grass, but an iris lily. Its six-petaled star

Why the Water Lily Rises with the Sun



At night the water lily closes and sinks into the water as in the first picture. With the dawn the curved stem straightens and the bud begins to open. By the time the sun is up, the full blown blossom is floating on a raft formed of its own sepals. This arrangement of sepals keeps the flower and its precious pollen from getting wet.

is borne on a stiff, flattened stem. It is a near relation of the purple flag of boggy river banks.

Acres of this purple flag, stems and sword leaves rising two feet high, are not uncommon. Big flowers of violet-blue, yellow at the base, and veined with purple, with several long, sheathed flower buds, crown the rod-like stalk. A spike of flag gives you a flowering branch for a week. The gold cluster of the marsh marigold is usually found with the flags, for nature likes to put purple and yellow together.

*Bouquets  
Made by  
Nature*

Beginning of the Summer Pageant

June is called the leafy month, but there are plenty of flowers. The wild rose spreads its pink chiffon petticoat in every grassy fence corner, along walls and clean waysides. It always has a single pink blossom of five, rounded petals and a forest of yellow stamens in the center. It may be a dwarf bush, long, straggling canes, or a climbing vine. But it is always thickly set with thorns, and its compound leaf has prickles. You gather scratches with roses. In June, too, the waxen cups of pond lilies float on every bit of quiet back water. Some older person should take a child or two at a time out in a broad bottomed boat, and push through the anchored fleets of lily leaves. One of the wonders of nature is how the snowy, gold-centered cups keep their purity unstained in water covered with slime.

By July the flowers have grown tall, and show burning colors in dry fields. Many of them are just



## The Companion Flowers of Autumn



"The tall plumes of goldenrod make a misty yellow background for the wild asters' ray-flowered clusters of violet and lavender."

brilliant weeds that are too coarse for picking—milkweeds, mulleins, jewel weeds and Joe Pye weeds. The cardinal flower, both red and

*The Burning  
Colors of  
July* blue, are fine spikes set with many tubular blossoms. The primrose has the loveliest odor, but its rose-like, canary colored blossom is too fragile for picking. The finest flower stalks of midsummer are the meadow, wood and Turk's-cap lilies. Yellow, orange, flame and blood-red, spotted with brown, they are all small, wild copies of the garden tiger lily. The lily bells and buds droop from whorls of ribbon-like leaves. The cone flowers, or black-eyed Susans, are the first of many varieties of field sunflowers, that bloom now. Every one of them has a many rayed circle of yellow petals set around a yellow, brown or black plush cushion. Next come the flowers of the autumn time.

The first flowers of autumn appear in August—the goldenrod, asters and black-eyed Susans. All the clovers—white, pink, crimson and the tall, shrub-like, sweet-scented clovers, tasseled with white, are still to be found; the delicate bells of the wild morning-glory; the white umbrellas of tansy; the frowsy, lavender-pink heads of spicy mint, and a few spikes of blue and crimson cardinal flowers. But by September most other colors disappear, and every waste place is a glory of purple and gold. The tall plumes of goldenrod make a misty yellow background for the deeper gold of the field sunflowers, the last mustard and dandelion blossoms and the sturdy spikes of "butter and eggs," those humble cousins of the snapdragons of the garden. And against this field of yellow the thistles lift their royal heads of purple plush, the ironweeds their reddish-purple



## The Lady's Slipper or Indian Moccasin



"From a stout stem, between two large veiny leaves, swings a pouch. Some are large enough for a dolly's shoe. One is snow-white, striped with pink. Another is golden yellow, lined with purple; another, pink."

lances, and the wild asters their ray-flowered clusters of violet and delicate lavender.

### Flowers of Different Sections

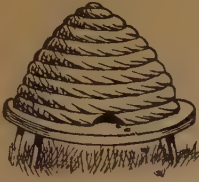
Now, if I were a "down east" Yankee child, I would hunt, in early spring for the tiny, pink-wax cluster, on a creeping, evergreen plant that the Puritans named the Mayflower. It is the trailing arbutus. It

has stiff, shining, oval leaves. It can be smelled before seen, and must be looked for among pine needles and drifted leaves in melting snow patches. Then, late in October, I would look in moist woods and meadows for the fringed gentian. On top of the stem, often three feet high, is borne a cluster of vase-shaped flowers, of the lovely silver blue of the Indian summer sky. The

vase top spreads into four, fringed lobes. These two flowers are the darlings of New England.

In the Allegheny Mountain states little folks wake up some bright June morning to see whole slopes covered with the rosy snow of the mountain laurel. This is *The Alleghenies and Their Laurels* a woody shrub, growing to a small tree in the south. It has thick, glossy, evergreen leaves, and five-pointed flower cups in big clusters. In sunny places the flowers are pink, in shady woods white. Although so big, it belongs to the same heather family as the Mayflower. And so does the azalea, which floods the southern woods and swamps with waves of white, pink and crimson bloom. The azalea is called the wild honeysuckle because its flowers are tubular, in clusters, are fringed with curly stamens, and

## How Flowers Make Use of Their Bee Visitors



it has a wild, sweet odor.

In the forests around the upper lakes, the Indian moccasin flower grows. From a

stout stem, between two large veiny leaves, swings a pouch. Another name for it is lady's slipper. There are several varieties, some large enough for a big dolly's shoe. One is white striped with pink. Another is golden-yellow, lined with purple. The whole plant has a primitive, wild-wood look as has Jack-in-the-pulpit, and the Indian pipe. The Indian pipe is the "ghost flower" of northern woods. It is a true flower, but it grows like a fungus. Fleshy stem, scale-leaf and pipe-bowl flower-cup are all waxen white, as if they were little spirit plants come back to their earthly playgrounds. When picked they turn black in your hands, and decay quickly. And tread softly among them. Where many people are passing they vanish altogether.

The eastern Rockies have so many beautiful flowers that it is not easy to say which is the best beloved. All the high plains below Denver are "green and blossoms in the spring, gold and blossoms in autumn." The

*The Flowers of the Eastern Rockies*

pale lavender bell, spotted with yellow and brown, of the Mariposa lily, is as fine as any garden flower, but it is not common. On the high plateau the Yucca, or Spanish bay-

onet, blooms in June. From a flat circle of sword-shaped leaves rises a stalk three feet high, hung with drooping tulip-shaped bells in white and pink. Thick stemmed, fleshy-leaved cactuses have brilliant flowers, often as big as peonies, in white, orange and blood-red. In the hot sun of deserts these dry plants seem to burst into flame.

California has many kinds of wild flowers—those of a foggy, windy coast; a fertile, sheltered valley; a warm, dry, sandy region, and snow-capped mountains. As John Muir the poet of the Sierras, said: "California is a sweet bee-garden—a bed of honey-bloom." But it is

This is how the common sage takes advantage of the bee's visit to distribute its pollen. The anthers are shaped like a reversed C. In Fig. 1 the pollen-bearing anther is at the top of the C, the old, used-up part at the bottom. Fig. 2 shows you what happens. As the bee pushes the barren anther upward in entering the flower, a hinge arrangement tips the pollen-bearing anther down so it brushes her back and the pollen is scraped off. Above the anthers is the pistil, drooping downward. As the flower gets older the pistil drops lower and then it brushes the bee's body; it is sticky and collects the pollen left there by the anthers of other flowers.





## PICTURED KNOWLEDGE

### The California Poppy



proudest of all of the silken yellow poppies that cover pastures and mountain slopes like banks of sunset; and of the manzanita. This is a heather shrub, a cousin of the laurel and azalea of the east. It blooms as early as Christmas. The purple-brown stems and pale, shining leaves can scarcely be seen for the thick clusters of fragrant, waxen bells.

#### **How to Pick the Wild Flowers**

When you pick wild flowers, do not take all that are growing in one place. Leave some to ripen seed. And do not rip up vines, or pull plants up by the root. If there are only a few, leave them alone. The very rarest of our flowers are disappearing—the lady's slipper, the Mayflower, hepatica, gentian, maiden-hair fern, columbine, Jack-in-the-pulpit and Indian pipe. Coarse weeds are tak-



This beautiful flower design was made by a high school girl on gray paper with wash and a little Chinese white. No forms are more beautiful than those that nature makes in flowers; and you have only to copy them faithfully.

ing the place of the dainty mountain laurel on many a forest hillside.

Besides, a few flowers are better than a bouquet, crowded as tight as a cabbage. A half dozen white or painted trilliums are enough for a slender vase. Violets should have their natural nests of many glossy leaves. A few stalks of blue flags, or tawny meadow lilies are prettier in a green vase than an armful. The Japanese, who make a study of flower arrangement, as we do of drawing and music, never use many together, and seldom mix more than two kinds. They make the prettiest use of single

flowering branches of shrubs. For big bunches, wait until autumn. You can fill tall jars with goldenrods, asters, black-eyed Susans and royal thistles, and never miss them from the fields.







Here are the most common poison plants. Upper left, monk's hood; upper center, berries of poison ivy; plant with lavender flowers, one of the lobelias. The delicious-looking black berries grow on the deadly nightshade. Below, at the left, is the deadly amanita and on its right the jack-o-lantern fungus which although not deadly would, if eaten, make you very sick.

# IN THE GREAT WORLD OF NATURE

## POISONOUS PLANTS

### *These Plants are Poison!* YOU MUST LET THEM ALONE

**"I** WISH I knew the Indian words for 'mustn't touch-it'."

That's one

took it quickly, with her handkerchief wrapped around the stem.

"You picked it with your mittens on, didn't you, dear? That's lucky." She held up the spray for the class to see. It was lovely, in its autumn gown of mottled crimson.

#### Remember What These Leaves Say

"See the three, broad, notched leaflets together, at the ends of the branches? Their names are Touch-Me-Not. This is the poison ivy that grows nearly everywhere in America. It

*Poison  
Ivy Found  
Everywhere*

is often mistaken for the Virginia creeper, but that has five leaflets. The poison ivy sometimes trails along the ground, but it likes best to clamber over rocks, fences, bushes, and to climb tall trees. Every part of the plant is poisonous to the skin of most people. The hands swell up to twice their size, and have a dozen kinds of burning, stinging, aching pains all at once, for days and days. Poisoned hands should be bathed with baking soda water, and bandaged with witch hazel. They should never be put

attention of a room full of fidget-y boys and girls. Instantly forty pairs of bright eyes became eighty snapping question marks.

"Because, this morning at breakfast, I had to say to little brother: 'Don't eat that, Billy Boy; it isn't good for you'."

"Oh, I wish I were an Indian, to live in the woods and eat what I like," he said impatiently.

"No real Indian boy would be as foolish as that. If he were, he would never live to grow up to hunt bears."

Just then the prettiest little girl—a blue-eyed, rosy-cheeked dumpling of a German Louise—

*What  
Louise Found  
in the Vacant  
Lot*

came in, out of breath, with a spray of vine from a vacant lot nearby. The teacher



Leaf of the Poison Ivy



"See the three, broad, notched leaflets together at the ends of the branches? . . . This is the poison ivy that grows nearly everywhere in America."  
Berries red, have no dread,  
Berries white, poisonous sight,  
Leaves three, quickly flee.

to the face. That is Lesson Number One in 'Plants that Every Child Should Leave Alone.' "

"Can we have Lesson Number Two right away?" asked the boy who had dug up the dandelion.

"Lessons two and three, four and five will be held at four o'clock

*Find Out* every day this week,  
*All About* in Wild Garden. You  
*the Ivy* are clever at drawing,

Johnny-Jump-Up, so you may make pictures on the blackboard with colored crayons, showing every part of this dangerous plant, then you will always know it. The rest of you may find out in books at home, everything you can about poison ivy, and write a story about it."

As the children scrambled into the Wild Garden at four o'clock, the teacher exclaimed: "Look at

that burning bush! That is our other 'mustn't-touch-it.' It is the poison sumac. This little tree with its long, feathered leaf, made of many willow-like leaflets, is often mistaken for the true sumac. But that has its little flowers and seeds in a stiff wine-red cone at the top of the stalk. The flowers of the poison sumac are in a drooping spray. Both give us beautiful autumn leaves of flaming red. All the other poison plants in our woods and fields are 'mustn't-taste-its.' "

#### Other Harmless Plants and Their Dangerous Twins

One boy who had been in the country in summer said he had eaten the sweet, crisp pith of a blade that he thought was calamus. It

The Poison Sumac



This is the poison sumac. "This little tree with its long, feathered leaf, made of many willow-like leaflets, is often mistaken for the true sumac. But that has its little flowers and seeds in a stiff, wine-red cone at the top of the stalk." Poison sumac berries are white.

was a wild flag. He was so ill that a doctor had to be called.

"Many poisonous plants look like the harmless ones, and taste like them. Wild parsnips can not be told from those that grow in gardens. All wild plants with much-divided, parsley-like, curly leaves should be avoided. There is a poison hemlock now!"

It was a pretty shrub, four feet high, with a many-branched, rigid stem, and saw-toothed curly leaflets making a big leaf. At the top were seeds in umbrella-shaped clusters that, in summer, had been small white blossoms. The branches were spotted with reddish purple. One of the boys dug around the root so that everyone could smell its pleasant odor. It is the fleshy root that is poisonous. It can be handled freely. The children crushed the leaves in their hands.

"Oh! They smell just like a little furry animal!" cried one girl. "Like the pet white mice I have in a cage."

"This plant got itself into history. The wisest man of old Greece — Socrates — was condemned to death for refusing to worship the Greek gods. A drink was made from the hemlock root and given him. It put him to sleep and he never woke

*Socrates and  
"The Cup  
of Death"*

up. So hemlock is called 'the cup of death.' It is a regular tramp of a plant, marching along every dusty roadside. The water hemlock of the swamps is poisonous, too. It is called the spotted cowbane, as cattle are often made sick by eating the leaves. The stem is spotted with red. The blossom and roots are much the same but the leaf is not so curly."

**Fool's Parsley**



When this plant is young it looks very much like garden parsley and is often mistaken for it, hence the name. It grows in waste places and neglected gardens.

**The Yellow Buttercup's  
Poisonous Cousin**

The next poison plant the children found grew as low as the violet. It was just a knot of spreading hand-shaped leaves, with five and seven broad finger leaflets. Upright stalks bore a single seed case. Some of the children remembered that it had had open, cup-shaped blossoms, like greenish but-

tercups in the spring.

It is a cousin of the pretty yellow buttercups. It belongs to the hellebore family, many members of which are grown in gardens for their beauty. One of them is called the "bachelor button." Powdered hellebore roots are used to kill insects and caterpillars on plants. The "white hellebore" is not a true hellebore. It has the parallel, veined leaves of the lily of the valley, and small green flowers set close on a stiff, fleshy stem. Very young children have died from bit-

ing the stem or root.

A wild geranium was found in the garden, too, with its fuzzy, lobed leaf like a hairy maple. In the spring this plant is known by its lavender-pink geranium flower, and in the fall, by its sharp, beaked seed-case. It is sometimes called the crane's bill, and sometimes the alum root. The root has a great deal of tannin in it, and puckers the mouth and stomach. It often makes children very ill.

#### A Kind of Milk That Makes One Sick

There were two members of the poisonous lobelia family in the garden—Indian tobacco and the cardinal flower. The Indian tobacco is a stiff-stemmed plant a foot high, with long oval, tobacco-like leaves. In the summer it has a small, blue, bell-shaped flower. The seed cup is a tiny, bulbous vase, the lips flaring open. A milky, rubbery juice runs from the broken stem. A very little of this acrid, biting milk causes vomiting. The beautiful cardinal flower of damp woods and river banks has milky juice, too, and so has the water lobelia, with its blue flowers. Many of the lobelias are lovely garden plants. They can be handled, but one should be careful not to get the milky juices on the hands. They quickly dry

Flower, Stalk and Root of the Water Hemlock



"The water hemlock of the swamps is poisonous. . . . It is called the spotted cowbane, as cattle are often made sick by eating the leaves. The stem is spotted with red." It has a big, bulbous root with large fleshy fibers, like most plants that live in damp places.

The cross section of the root shows the partitions dividing the interior into little rooms.



to a kind of rubber. Indeed, many careful people wear old gloves when gathering flowers, to protect their hands from disagreeable juices, and from briar scratches that are often painful.

**Why Mr. Jimpson of Jamestown?**

"Ah, there's a fine Jamestown (Jimpson) weed," cried the teacher. "You would never mistake that stocky shrub, with the big, glossy leaves and white bell blossoms as big as morning glories, for anything else. It has a poisonous juice, like opium, that is made from poppy seed. You should never eat poppy seed, mustard, or any wild seeds at all."

**Only Three Wild Berries That Are Safe to Eat**

"Blackberries, raspberries and strawberries are the only wild berries that are safe to eat. Elderberries are wholesome, but children often mistake the deadly poke-berries for elderberries, so that it is best to leave them alone. Scarlet bittersweet and mountain-ash berries are beautiful in flower vases, but are poisonous to eat. Wild grapes are so acid that they often cause cramps and throw little children into spasms."

**Don't Mistake This for Wild Horseradish**



"There's one root I think Indians used," said Billy Boy; for Billy Boy was a boy who thought. "It is horseradish. You grind the root up in vinegar, and use it on boiled beef. Wouldn't horseradish in

wild grape juice be fine on bear meat!"

**It Looks Like Horseradish, But It Isn't**

"Yes," said the teacher, "I think it would be. But this plant you are looking at is monk's hood, with horseradish-like leaves. Its purple hood or helmet-shaped blossom, grows loosely along a spike. It belongs to the poisonous aconite family. The true horseradish belongs to the same family as the garden radish, turnip and wild mustard.

It has the same little four-petaled, cross-shaped blossom and podded seed."

Last of all the children hunted

around the rotting stumps and a fallen log, and along dry, grassy banks for the little umbrella-shaped fungi that they called "toadstools." Such pretty ones they found—white and cream, yellow, orange, gray, smooth and scaly and spotted, with white, brown and gray gills

**The Pretty Little Wild Umbrellas**

like ruffles underneath.

"They are just like the mushrooms mama buys in the market," insisted one little girl. "They are so good!"

#### Difference Between Toadstools and Mushrooms

"They certainly look like them; but, growing wild as these are, I think they are the death-cup fungi. The cap is smooth, a pale, creamy white, and the gills and stems a bleached white. They grow in every open wood and meadow. Sometimes the cap is pure white or olive and scaly. This beautiful one with the yellow cap is the deadly amanita. It grows in rich earth, around rotten stumps and in groups. The cap may be any shade from white to orange-red. Around the base of the stem is a scaly ring, and then a swollen bulb that is partly buried.

#### A Plant That Puts People to Sleep



Here is the henbane, that secretes a juice similar to belladonna. It is very poisonous to all living things, but especially so to chickens. Like the poppy and the hemlock it makes people go to sleep.

#### Jack and the Lantern in His Cap

"Those tricky-looking ones growing together at the base, and bend-

*Jack and the Lantern in His Cap*

ing away at every angle, are Jack-o'-Lanterns.

The whole plant is a saffron-yellow. After nightfall the caps are often aglow with a faint

light, like the heads of phosphorous matches when you rub them. There are good mushrooms in the woods, but people who have not made a special study of books on mushrooms and toadstools should leave

all the fungi alone. A good motto for a child would be:

"All fungi in the woods and fields are toadstools."

#### But What Did the Indians Eat?

"Why Indian boys and girls had to leave nearly everything alone. What could they eat?" (For Billy Boy was troubled about his little red friends-that-used-to-be.)

"All the nuts, many wild fruits, even sour cranberries, grapes and plums, if they had maple sugar to cook them with; water cresses, mustard, wild on-

ions, wild rice. But so few wild plants are wholesome that the Indians were obliged to grow corn, beans and pumpkins. Many leaves, roots, barks and seeds that were unfit for food were good medicine. Indian children were watched every minute. They were brought up on:

"'Mustn't-touch-it. Don't eat that; it isn't good for you.'"

The boys were swinging their legs over the cement walk into the

tangle of growth of the Wild Garden. At last Johnny-Jump-Up said disgustedly:

"One might as well be a white boy."

"It is just as much fun, and far safer." The teacher was smiling. "Run along, now, or Jack-o'-Lantern will have to light you home."

## Daffodils

*I wander'd lonely as a cloud  
That floats on high o'er vales and hills,  
When all at once I saw a crowd,  
A host of golden daffodils,  
Beside the lake, beneath the trees,  
Fluttering and dancing in the breeze.*

*Continuous as the stars that shine  
And twinkle on the milky way,  
They stretch'd in never ending line  
Along the margin of a bay;  
Ten thousand saw I at a glance,  
Tossing their heads in sprightly dance.*

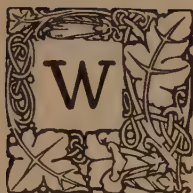
*The waves beside them danced, but they  
Outdid the sparkling waves in glee—  
A poet could not but be gay  
In such a jocund company!  
I gazed and gazed, but little thought  
What wealth the show to me had brought.*

*For oft, when on my couch I lie,  
In vacant or in pensive mood,  
They flash upon that inward eye  
Which is the bliss of solitude;  
And then my heart with pleasure fills,  
And dances with the daffodils.*

WILLIAM WORDSWORTH







WE can now travel in any land, in any season, or among any tribe or race, snugly ensconced, with a few illustrated books, by our own fireplace. The limit and range of what pictures can do is steadily increasing. One can know many of the wonders of the vast new world of the microscope and telescope without ever looking through an eye glass. It would be a curious question for the imaginative mind to work out how far an education based upon a wise selection and proper gradation of pictures might today be carried without the ability to read. If all written or printed records of the present time should be lost it is surprising to reflect how much of what makes life interesting could be reproduced by pictures alone. Seeing is not only believing, but understanding, and a single judicious picture or blackboard drawing often tells in a moment what it would take paragraphs to describe, if indeed words could ever give it at all.

G. STANLEY HALL

## Jealous Mr. Hornbill



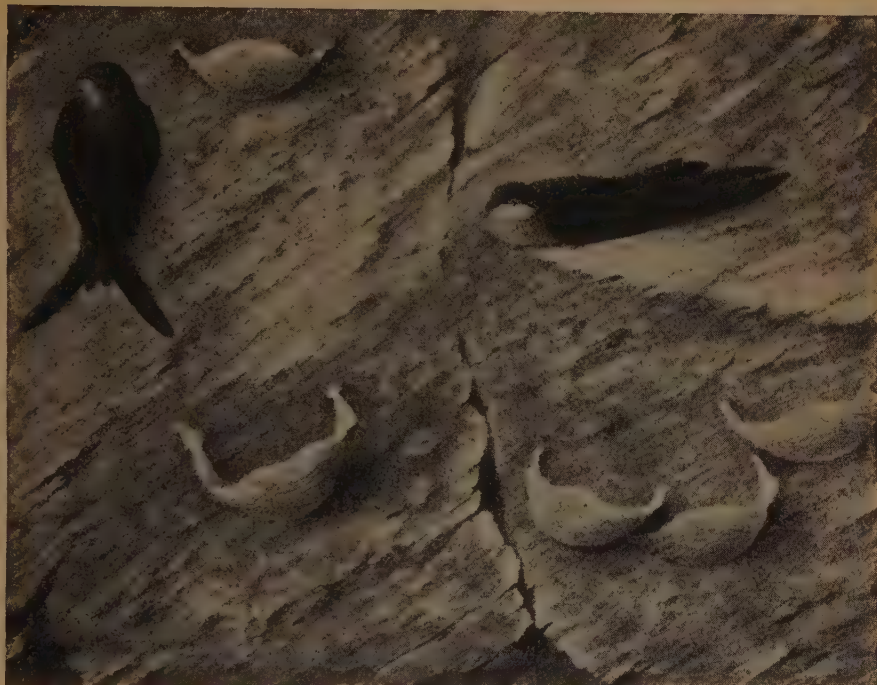
### How the Hornbill Walls-in His Mate

"He walls her in, leaving a hole for the tip of her beak. For two months he feeds her and the downy babies with fruit through the hole."



# IN THE GREAT WORLD OF NATURE ANIMALS' HOMES

## Some Curious Homes of Animals



They are cliff dwellers, gluing their nests in colonies to the rocky walls of caves, above the sea, in the far-away East India Islands.

**N**EARLY all animals except grass eaters, that live in herds in the open, and insects that live in the sun only a few days or weeks, have some kind of a home. Lions live in natural caves, wolves and foxes in dens and bears in hollow trees. But all the birds, most little furry animals and bees, ants, spiders and wasps make their homes. The only tools they have are their feet and mouths, but they use these in the cleverest ways for spades, saws, augers, needles, weaving shuttles,

*Birds' Nests  
that are  
Good to Eat*

knives, shears and trowels. They make the cleverest, cosiest homes in which to hide and sleep, store food and bring up their helpless babies in safety. Caterpillars make a gummy silk to wind about their bodies, bees make wax cradles and honey jars, and spiders have a silk for weaving their wonderful dens and fly traps. But did you ever hear of a bird that draws threads of saliva from its mouth and weaves a nest with them?

Wung Foo, the little Chinese boy, could tell you all about that,

## A Bird Village in a Tree



Like a human village, the bird colony is built up slowly. A single pair of birds makes a nest with an awning of long, tough grass. The next year this pair returns, bringing their children. Year after year the nests increase until the tree is surrounded and the sloping roof extended, to shelter dozens and even hundreds of families.



would give you bird's nest soup for dinner, but he could not show you where to find such a nest. It is made by swallows, very much like those that make mud villages under the eaves of barns.

They are cliff dwellers, gluing their nests in colonies, on the rocky walls of

*Weaving "Glass" Houses caves on the Cliffs* above the sea, in the far away East India islands. The bird presses its tongue against the rock to fasten the end of a thread, then flies back and forth, pulling out a cord that dries and hardens almost at once, and weaves it into a basket nest the size and shape of a quarter egg shell. It is a pretty amber in color, as clear as glass, and melts in hot water. It is made in pitch darkness, in the night, the birds flying like bats.

#### A Bird That Builds a Tenement House

Of all our native birds the orioles are the cleverest nest builders, weaving a hanging purse or pocket from an elm bough fifty feet in the air. But in hot countries there are orioles that weave double nests. The

inner room is for mama and the babies. The papa bird sleeps in the entry to keep an eye out for burglars. The buffalo weaver birds join company and build several nests

together. The sociable weaver bird of South Africa makes a tenement house around the trunk of a stout tree, and under an umbrella roof big enough to shelter several men. Like

*Tenement a hu- House Around m a n Tree Trunk* village the bird colony is built up slowly. A single pair of birds makes a nest with an awning of long, tough grass. The next year this pair returns bringing their children. Year after year the nests increase, until the tree is surrounded and the sloping roof extended, to shelter dozens and even hundreds of families. Bats, insects and snakes find shelter there, too. It is a noisy tenement house, everyone crying, scolding and quarreling, but all safe under a conical roof that is strong-

er than the roof of many a bushman's grass hut. The bird that weaves this wonderful tenement-like

A House with a Real and a False Doorway



The real entrance to this weaver bird's nest is at the bottom. Half-way up is a mock opening, made to deceive possible enemies. Mama Weaver and her babies are in the rounded out part at the top. There is a strong partition between this and the "spout" to keep the eggs and babies from falling to the ground. Papa Weaver is pecking at you over the edge of the log.



nest is only six inches long. red, and is called the diamond bird.

**What Do You Think of This, Girls?**

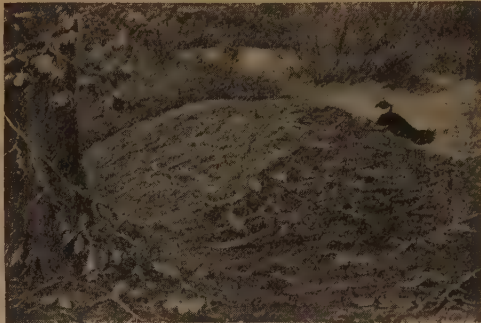
The tailor bird sews her nest. She selects a large, strong leaf growing from the tip of a twig. All around the edge she pierces a row of tiny holes with her bodkin bill. Manuelo, the little Filipino boy, lies very still in the woods and watches her do it. She finds another leaf of the same size and shape and makes holes in that. Then she strips bark from tough weeds, splits it into threads and sews those leaves into a deep bag. In the bottom she makes a bed of down.

**Two Burrowing Birds**

In Australia, that is noted for its queer plants and animals — blue gum trees, kangaroos and laughing jackasses, which are parrots that hee-haw — there is a tiny bird, three and a half inches long, that *digs* a nest. It is a flashing jewel of black, white, gray, brown, yellow, orange and blood-

It tunnels a gallery for two or three feet into the earth, then hollows out a perfect three-inch globe that it

**Hatches Her Eggs with an Incubator!**



The Australian mound-bird makes a nest of leaves and grass and lays its eggs in it. Then it piles more leaves and grass on top of them until they are buried two feet deep. This is how the finished mound looks. These mounds are sometimes forty-five feet in circumference. The leaves and grass decay and in so doing produce heat, as you know, which helps hatch the eggs.

lines with bark fibres. This work is, of course, done in complete darkness.

The puffin, a queer water bird of the Faroe Islands, makes a V shaped burrow with two entrances and a nest at the bottom. It folds its wings and webbed feet

and toboggan-slides to its home. It sleeps standing upright, as solemn as a fat alderman.

**Jealous Mr. Hornbill of the Far East**

**The Brazilian "Johnny Clay" and His Home**



Here is the oven-bird of South America and his nest. It is built of clay on the bough of a tree, and has a long narrow opening. It is like the clay ovens used by primitive peoples and from it the bird gets the name. The people of Brazil call this bird "Johnny Clay."

You know that our native woodpeckers, owls and some blue birds nest in holes in trees. The hornbill of the Far East does this, too. It is as big as a pigeon or a crow. When mama bird has moved in, lined the nest with feathers and laid two eggs, papa

fetches clay and walls her in, leaving a hole for the tip of her beak. For two months' he feeds her and the downy babies with fruit, through

the hole. But if Mrs. Hornbill breaks that wall or lets another bird feed her, Mr. Hornbill goes away and never comes back.

### Feathered Barons in Cliff Castles

Like many other water birds, penguins live in colonies. Thousands come together, every spring, on every arctic sea beach, and hold a congress. Selecting a wide ledge above the sea they fetch stones and lay a wind-break wall around three sides of a space that covers several acres. The inclosure is marked off in squares, with streets and lanes. Each square is a nest, the castle of a pair that no other bird ever disturbs.

### A Beautiful Three-Roomed House

The shadow birds of South Africa, that live on marshes, build dome shaped forts, of clay and sticks, four feet high, and strong enough for a man to stand on.

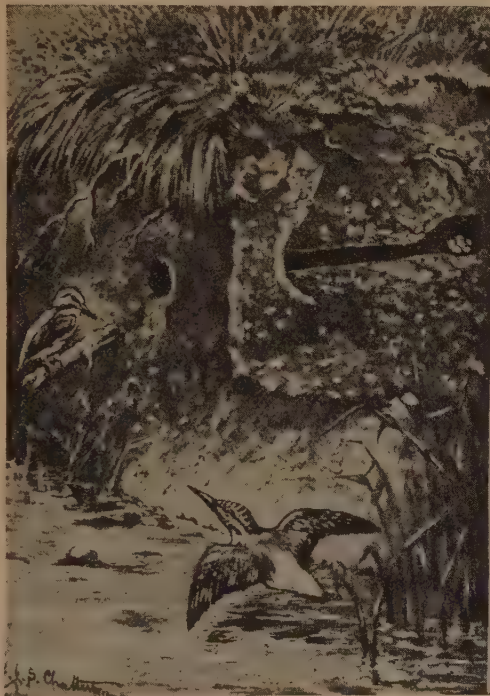
### A Bird that Decorates His Home

Mama and the babies sleep on beds of leaves and grass in the inner

room. The middle room is a pantry always stored with such dainties as fresh frogs, fish and water snakes. When the owner is at home he sleeps inside the door with his beak out. Like the English magpie he collects bright objects, bits of metal, china, glass and pebbles, with which to decorate his front door yard.

### And There Are Bird Play Houses, Too!

### The Kingfisher



The kingfisher lives on fish and builds its nest in the banks of streams and lakes. In the picture the bank is cut away showing you a cross-section of the kingfisher's tunnel and nest. The birds spit up undigested fish bones and form them into a cup-shaped nest for the pure white eggs of which there are usually six.

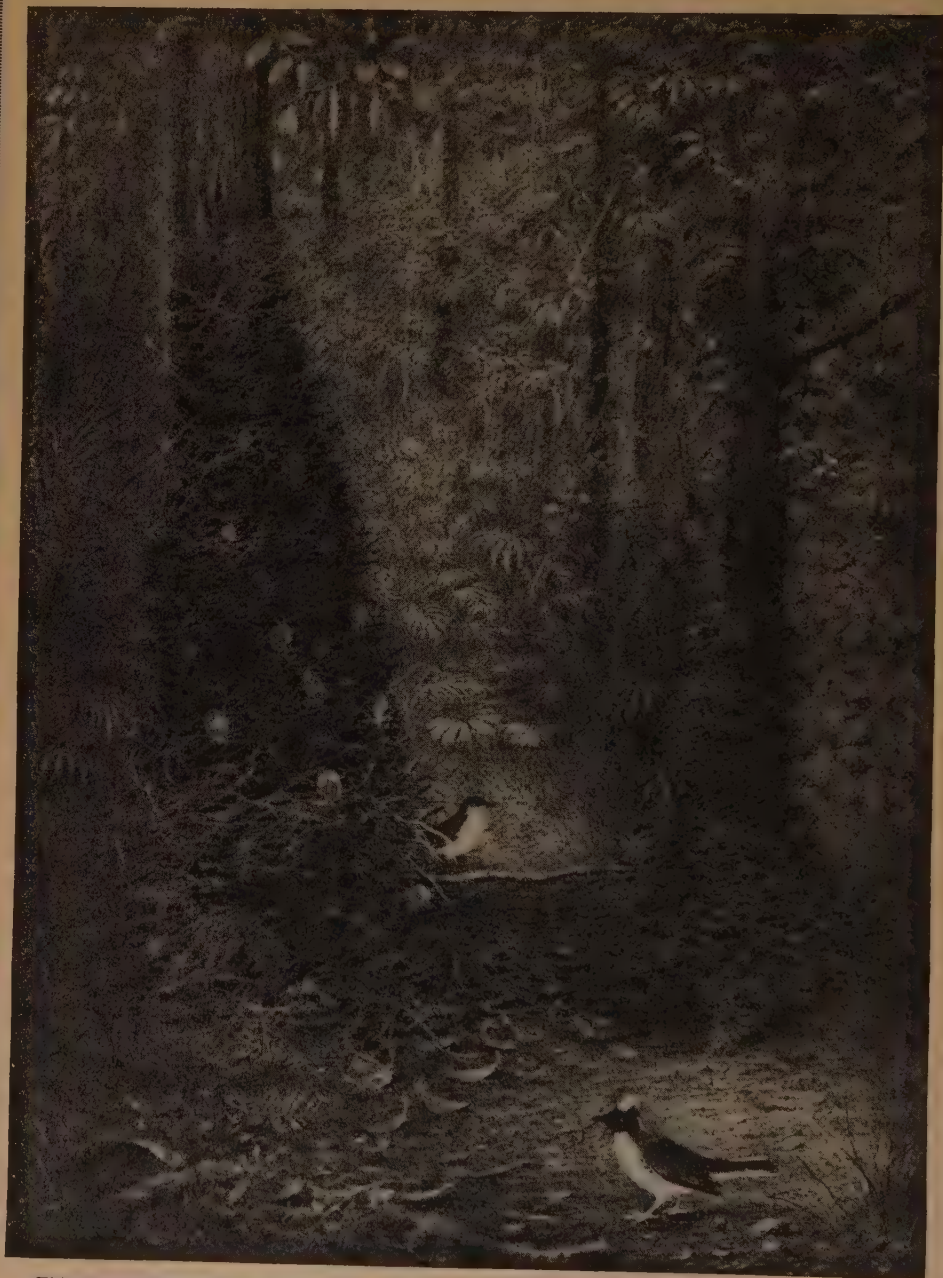
a cone for support. Then it makes a leafy tent, using an air plant that will not *wither* (think of that!). The house is evergreen and waterproof, nearly two feet high, with an opening in front. In front the gar-

This sounds like a fairy tale, but it's as true as blue. The bower birds of Australia and New Guinea build pleasure houses. For bringing up their babies they have ordinary nests high in the trees. But on the ground they build summer houses and lay out gardens. One kind builds around a woody plant with a stem as long as a parasol. This it uses for a tent pole. It digs up the earth around the roots and piles

### Play Grounds for Bird Babies



## A Bird's Amusement Park



This is the pleasure house or park built by Newton's bower bird. Two trees about a yard apart are surrounded with twigs, as you see, until the piles meet in the middle. The piles are added to from year to year and one side is built higher than the other. The birds decorate the higher side with flowers and moss. White orchids and rock lilies are their favorites.



## A Wasp's Apartment House



"You will often see wasps wherever there is wood weathered to a flaky silver. They pull off tiny slivers, chew them to a pulp and spread the pulp to make six-sided cells, arranged in combs. The nests are hung, cell mouths downward, and are almost enclosed in a shell of tough gray paper." On the left is the gray paper home, hanging entrance downward from a sloping roof. To the right, part of the outside wall has been cut away showing the layers or "apartments" of comb, suspended one from another upon gray paper pillars and attached to the walls of the house.

den is dug up and turfed with moss. Scattered over it are flowers, fruits, butterfly and beetles' wings. When these lose their freshness they are replaced. One bower bird makes a green arch over the path to the front door. The birds are about as big and plain as our robins. For hours every day they work about their pretty playhouses, hunting new bright ornaments and carrying away dead leaves and blossoms.

**Did You Ever See a Bumble Bee's Nest?**

Insects are just as clever home builders as birds. There are solitary carpenter bees that tunnel in trees, lay one egg in the bottom, put in a supply of honey and pollen and fit in a ceiling of sawdust and gum, as thin and round as a silver dime. Another cell is made on top of that, and another, until the nest is filled. The *Andrena* bee is a miner. It sinks an up and down shaft, with chambers budding out on either side, each holding an egg and food for the baby grub. The queen bum-

ble bee living over winter, makes a nest in any hollow place in a clover field. She collects grass and moss to hide the nest.

*Miners that Live Underground* Then she makes a cluster of wax cells and brings up a brood of babies much as the honey bees do. The leaf cutting bee makes a tube nest, in a hollow stem, lining its ovals and circles cut from tough leaves and cemented together. Ants make as many kinds of homes as bees. There are burrowing wasps, too, but most wasps make paper nests.

**The Wasp's Little Gray Paper House**

You will often see wasps about old fences, barns and wherever there is wood weathered to a flaky silver. They pull off tiny slivers, chew them to a pulp and spread the pulp to make six sided cells. The cells are six sided, like the bee's wax cells, and are arranged in combs. The nests are hung from bushes and trees, cell mouths downward, and are almost enclosed in a shell of tough gray paper.

Like a Little Old Man on a Bench



This nest or platform is sixty feet in the air in a tall tree in Borneo. Its owner, the orang-utan, is squatting on it with his hands clasped. Isn't he just like a round shouldered little old man? The orang-utans sleep in their nests in the trees until the morning sun has dried up the dew and mists on the ground.

A Mole Hill in Cross Section



"Under the center of a mole hill is a round room, surrounded by two circular tunnels, one above and smaller than the other, and connected by up and down passages. From the lower circle tunnels run away in several directions. The little animal has a nursery where several tunnels meet."



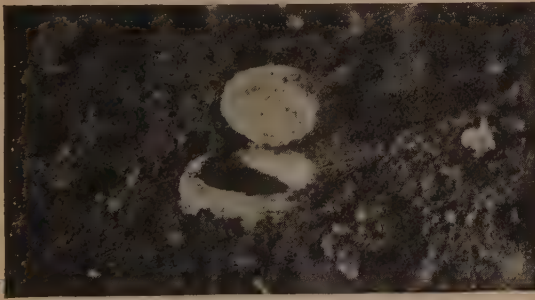
### The Trap-door Spider That Plays "Jack-in-the-box"

Don't you think a Jack-in-the-box amusing? You press a button, the lid flies open, and "Jack" pops out, on springs, and makes you jump. There is a spider that is a live Jack-in-the-box. It is the trap-door spider. It digs a hole in the ground as big around as a penny and about a foot deep, and makes a cover for it of earth and cob-webs that fits as

snugly as the lid of a watch. Then it lines nest and cover with silk and

woodchuck, paws folded, barking like a nervous little dog.

### The Jack-in-the-Box Spider and His Door



The trap-door spider "digs a hole in the ground as big around as a penny and about a foot deep, and makes a cover for it of earth and cob webs that fits as snugly as the lid of a watch. Then it lines nest and cover with silk and hangs the door with a strong hinge. . . . Even if you found one of those doors you might not be able to open it. The owner can hold it shut with her legs braced against the walls."

### The Interesting Little Prairie Dog Town

Of the little furry animals it is

### Wasp "Cliff-Dwellers"



A cross-section of this bank shows how the mason wasp digs a branching burrow for its grubs to hatch in. The entrance to the burrow is a mud-built tube with jagged ends. A wasp is entering the end of one tube. There are also holes along the sides, by which the wasp can go in and out.

hard to say which one makes the cosiest home. There are rats, mice, squirrels, prairie dogs, gophers, moles and many others. Many people think a prairie dog village the most interesting thing any child could ever see. On our dry plains, acres and miles of wild country are dotted with hillocks two feet high. On top of each hillock, near a hole, sits a lively little ground squirrel about as big as a

"Yap, yap, yap!" they yelp. But if you go too near them they vanish with saucy flirts of their tails: "Good-bye, I have business below."

Don't you wish you could follow them? If you were a brown-

ie you could go with them through miles of tunnels, and see their cosy nests lined with moss and fur. And



## How a Beetle Makes a Nursery with a Leaf



The leaf-rolling beetle begins by making queer, curved cuts at the top of a leaf. In the first three pictures you can see the beetle at work. We see her rolling part of the leaf backward. The lower left hand picture shows one side rolled. In the last figure she is rolling the other side over this and enclosing herself in the process. While she is hidden she lays her eggs. When she comes out she tucks up the point of the leaf and fastens it down.

## "The Dearest House of All"



"The dearest house of all is the nest of a field mouse. . . . If you ever found the nest you would be sure to think it had been built by a bird and filled up with loose grasses. It is a couple of feet from the ground fastened to grasses, is as big as a goose egg and woven of grasses in a ball. You would see no opening at all, but from five to nine thimble babies are packed away inside. Mama and papa mouse can push the grass aside anywhere to get in and out, and the hole closes again at once."

maybe you would find out where they get water. Some think these little animals dig wells. Owls and

rattlesnakes live with them and make trouble. When outside the prairie dogs mend their hillocks by patting the earth hard. Then they sit and visit and bark in the sun.

## A Friend and a Foe

The gopher is a kind of squirrel that burrows in fields and gardens. It has a dozen tunnels leading from *Many Roads to His Little Home* every direction to a central nest lined with fur and grasses. It lives on roots and is troublesome to farmers for it is so swift and has so many ways of escape that it is seldom caught.

The mole is the farmer's friend for it lives on cut worms and beetles around plant roots. Under the center of a mole hill is a round room, *The Mole's Mysterious Middle Room* surrounded by two circular tunnels, one above and smaller than the other, and connected by up and down passages. From the lower cir-

## Water Voles at the Doors of Their Homes



The water vole is a species of field mouse that lives in swampy places. It builds a long burrow at the end of which is a nest lined with down where the babies are hidden. Can you find the entrance to two burrows in the picture?

cle, tunnels run away in several directions. What the middle room is for, no one knows. The little animal sleeps in one of the passages, and has a nursery where several tunnels meet.

#### Clever Caterpillars

We will tell you about seal, beavers, water spiders and nest building fish in another story. There are just two more that we have room for here.

You have seen the nests of tent caterpillars, haven't you? A big colony of caterpillars enclose a branch of a tree in a web of silk, eat the leaves there and spin their cocoons. Birds could easily tear that web in pieces and gobble up the squirmers, but they do not seem to know it. In Mexico a colony of caterpillars weave a bottle shaped bag of a parchment paper, as tough as a wasp's nest. It has a small opening at the bottom. Inside, the pupas are hung up by the tails.

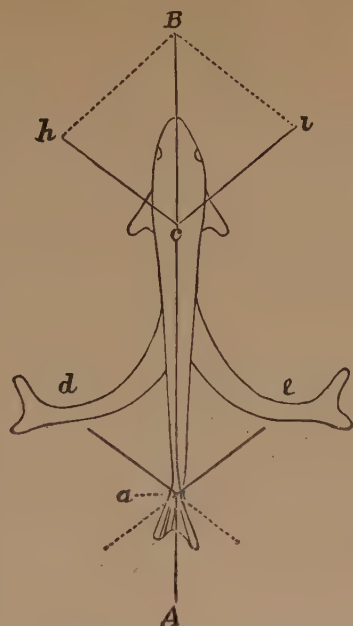
*Caterpillars  
that Live  
in a Bottle*

#### Sweet Little Home of the Field Mouse

The dearest home of all is the nest of a field mouse. Little bright-eyes of the meadows, this tiny animal is six and one-half inches long, tail and all; two-tenths of an inch less than a house mouse. He is red-brown with a white vest, and is so cunning when he sits up on a grass stem to wash his face, or to eat the kernel of corn that makes a meal for him! If you ever found the nest you would be sure to think it had been built by a bird and filled up with loose grass. It is a couple of feet from the ground, fastened to grasses, is as big as a goose egg and woven of grasses in a ball. You would see no opening at all, but from five to nine thimble babies are packed away inside. Mama and papa mouse can push the grass aside anywhere to get in and out, and the hole closes again at once. And then the little family of field mice is safe in its cosy, round home, as snug as the apple in a dumpling.



# How a Fish Swims



## Switching His Tail for You

Little Friend Fish is here showing you how he swims. The line AB indicates the center of his back. His "center of gravity" (see dictionary) is at c. The lines d-a and e-a show the motion of the strokes that drive him forward. The lines c-h and c-i show how the fish swims in a zig-zag and not straight ahead.

**H**OW does a fish swim? That's easier done than said. The easy, graceful way in which a fish seems to move through the water is really quite complicated. You will say that a fish swims with his fins. It would be more nearly true to say that a fish swims with one fin and

steers himself with the others. For it is by the use of his big tail fin that the fish can dart rapidly about, jump into the air and swim steadily against a swift current or through big waves.

Water animals, like the whale, use an up and down stroke of the tail in swimming, but most fish move their tails from side to side. For example, a stroke to the right is taken with the tail partly or wholly folded, then the return stroke back to a straight line is stronger and push-

es the fish forward through the water obliquely to the left. A mild stroke of the tail to the left is followed by a strong stroke back to a straight line again, which carries the fish forward a little to the right. So really the fish travels not in a straight line, but in a zigzag. Watch a gold fish and see.

The fins on the sides of a fish's body are not supplied with such large muscles as those which control the tail fin. The chief use of the other fins is in balancing and turning. They are rudders and paddles which the fish uses to keep his course straight. By spreading them out or closing them, giving the water an occasional stroke with them, he keeps his nose pointed toward the place he is swimming toward, and relies on the strong back sweep of his tail for speed.

## The Queer Coffer Fish



You might think this a Hallowe'en mask, but it isn't. It's his face! One of the strangest of the water animals, he is called the coffer fish. He may not even know how to play Hallowe'en things at all but evidently he likes to play blowing bubbles. Watch him do it.

IN THE GREAT  
WORLD OF NATURE  
WATER ANIMALS

# Some Strange Water Animals

## *The* Crab and the Boarder that Lives on the Roof



"The strangest partnership of all is that of the sea anemone and the hermit crab. The crab gets a house by eating a shell fish and then backing into the shell. On the roof a sea anemone takes up its home. The crab feeds its companion by pushing up dainty morsels with its claws. When the crab outgrows its house and is obliged to move it pries off its flower-like 'chum' and helps it to move too!"

**W**HEN you go swimming do you dive? And how long can you hold your breath under water? About half a minute? That would make a whale laugh. Just imagine a laugh sixteen feet wide! Why, a whale can dive two or three hundred feet, and stay down forty minutes!

*A Mouth as  
Wide as a  
City Street*

But it does not do that unless it is trying to get away from a boat load of whalers with cruel harpoons. Usually it comes to the surface every ten minutes, blows the vapor from its lungs, through

its ten inch slits of nostrils, in a dozen snorts, gulps as many deep breaths and drops below the surface.

### Why a Whale is Not a Fish

It is a pity a whale is such a big animal, often eighty feet long, that it cannot be kept in an a-quar-ium, or water museum, for it is so interesting. It is not a fish but a warm-blooded mam-mal, or milk giving animal. You should see a mother whale nursing her twelve foot baby, just as bossy cow nurses her calf. To



keep its red blood warm a big whale has a two foot blanket of fat under its skin.

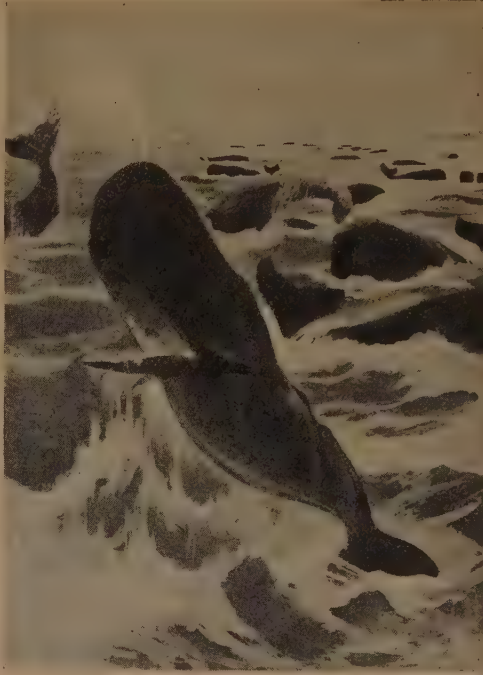
Wouldn't you think such an "e-nor-mous" big animal would live on huge fish like the cod? But its throat is only an inch and a half wide. As it swims along, mouth open, as fast as a horse can trot, little soft-shelled fish and minnows float in. They cannot get out again. From the roof of the whale's mouth a fringe of flexible whalebones falls to either side, like a stiff feather, making a strainer. These whale bones often weigh two tons!

Some whales travel alone, but the twenty-foot white whales swim in schools. Like their little cousins, the dolphins or porpoises, they frolic in the water. They leap over and chase each other. A big whale can smash a boat with his twenty-five foot wide tail, pull out half a mile of heavy cable "fishing line," and sometimes break it.

The funniest thing about a whale

is that, although it has no more hair on its elephant-like hide than an old rubber boot, it has whiskers like a cat.

## The Monarch of the Sea



Although not so large as some of the whales—he only weighs about 110 tons—the sperm whale is regarded as the monarch of the waters because of his heroic character and his majestic appearance. He never looks for trouble, but will fight anything that attacks him. When poised upright in the water, as you see him in this picture, he looks like a column of black marble. On the opposite page he is having a lively dispute with another huge ocean creature, the octopus.

Isn't it curious that such a big, ugly thing as an octopus should have the same kind of feet—that is to say, sucker feet—as the little flies that, by means of their sucker feet, can walk as well upside down as right side up—and on slippery window panes, too?

That lower jaw of the whale is a shaft of solid bone about 30 feet in length and has between fifty and sixty back-curling teeth in it.

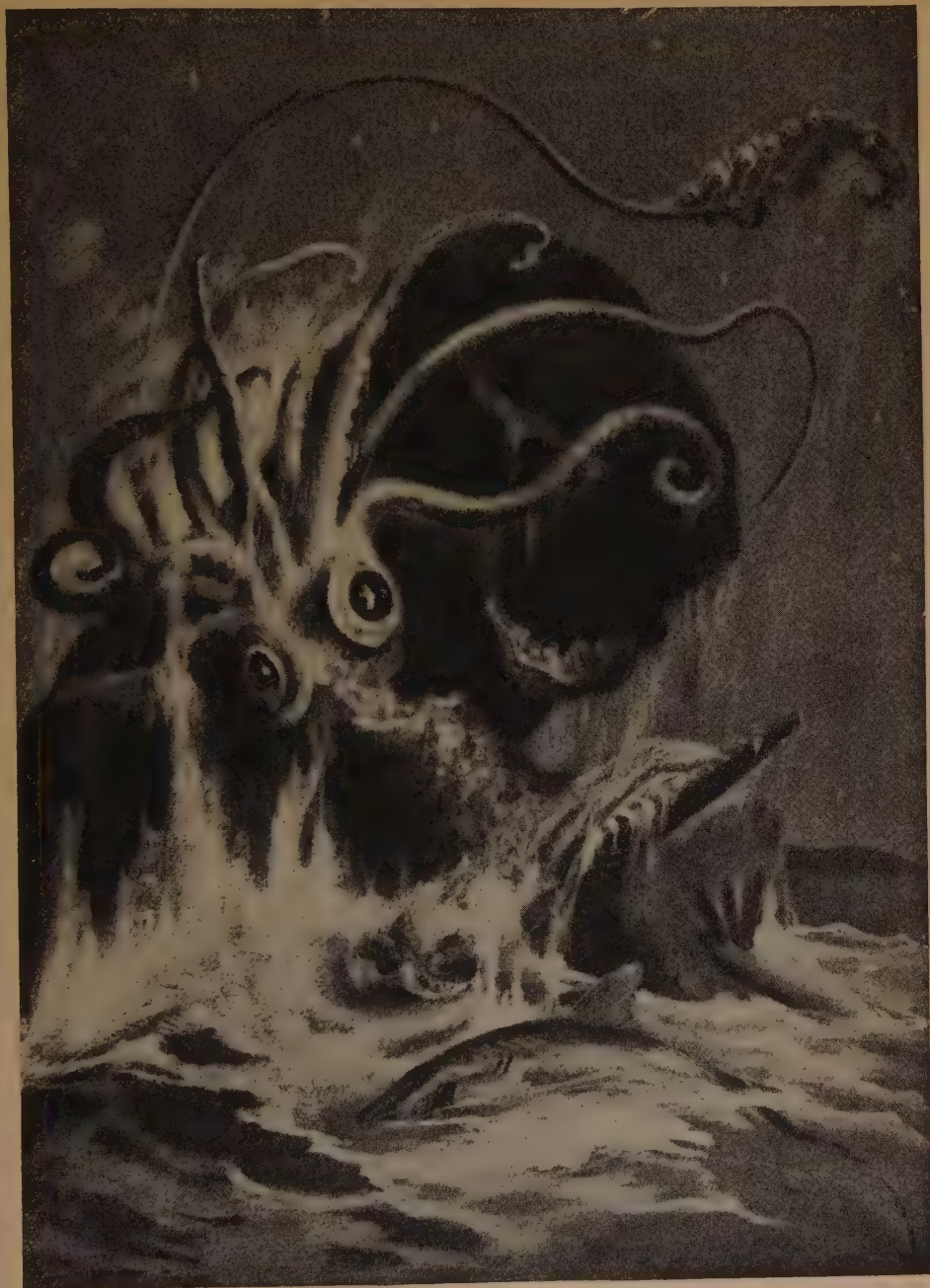
island. They wriggle and shuffle and jump on their flipper feet. They bark and grunt and squeal and bleat. And they catch the fish in their mouths as cleverly as boys catch balls. They know their names when called.

### Sea Lions, Dogs and Horses

The seal has whiskers too, but it has the long-muzzled head of a dog, the velvety fur of the beaver and the webbed feet of a duck. A seal can stay under water fifteen minutes. After a long swim it likes to come up on the ice, rocks or sand and sleep in the sun.

In many city parks sea lions, which are really our fur seal, are kept in deep ponds with high iron fences around them. Once a day the keeper feeds them with good sized fish. They smell those fish before you do. Out of the water they scramble onto a rocky

## A Dispute With the Monarch of the Deep



Here the sperm whale is having a dispute with an octopus. The octopus is using his powerful arms and his sucker feet in the struggle.

In the foreground is one of a school of sharks who are also attacking the cuttlefish. Sharks do this just as jackals follow lions on their haunts in the hope of "sitting at the second table."



## The Whale is Attacking the Men



In the Antarctic Ocean there is a species of whales called "killer whales" because they attack and kill other creatures for food. The picture shows one of them trying to roll a party of men off from an ice floe on which they are adrift.

Think of the noise a hundred thousand of these animals must make when they come together on an island in the Behring Sea. The babies are born on land. Each mother, who is about as large as a big dog, has one or two babies. Old bull seal are often eight feet long, weigh eight hundred pounds and are as cross as bears. The woolly babies are afraid of the water and have to be taught how to swim. If you should go among them the seal would crowd around you, just bursting with curiosity about such an animal as you. If you played to them on a flute or violin they would sit as still as mice.

*Water Babies  
that Fear  
the Water*

In the winter seal live in the water. Each one keeps an air hole open in the ice. Above this hole a den is formed in the snow. The baby seal sleeps there and the

mother brings it dainty bits of food.

The walrus belongs to the same family as the seal and sea lion, but it is three times as big, weighing as much as an ox. It has no fur, but it has ivory tusks two feet long. It uses these to climb with, to pull sea weeds, to dig clams and to fight the polar bear. The bear turns tail and runs from these armed sea horses. Really the walrus is rather ill-tempered. I don't for one minute believe that

*"The walrus and the carpenter  
Were walking hand in hand"*

as the poem says, in "Alice in Wonderland." It would never be as friendly as that.

### Fish Man-Eaters and Pirates

But the walrus is simply a bully, like a surly dog. And there are tigers in the sea. They are great blood-thirsty fish thirty-five feet



long. They have mouths and throats big enough to swallow a man whole, and the mouths are full of rows and rows of sharp saw-like teeth two inches long.

These are sharks. There are twenty varieties of them and they live in every warm ocean in the world. Not one of them is of any use, but they are the tigers, wild-cats, vultures and hawks of the deep. They eat millions of good food fishes. Dog fish bite holes in fish nets. Big sharks follow ships to feed on food thrown overboard. Regular man-eaters prowl around tropic beaches, so that it is dangerous for people to go in bathing. They can jump ten feet out of water and drag fish out of a boat. They can upset boats with blows from their tails. A chain line is the only one that can hold them for they can bite rope cables in two.

The sword fish is the pirate of warm and temperate waters. It ought to carry a black flag. It often weighs two hundred and fifty pounds. The upper jaw is elongated into a double-edged sword as hard as steel. Sometimes the sword fish plunges its weapon through the oak planks and copper plates of a boat and breaks it off. It probably thinks the boat a whale or shark. It uses its sword to kill food. On the coast of Maine this pirate swaggers about in a school of pretty mackerel, slaying right and left. Turning on its back it picks up the pieces. No sharks or sword fish can be kept in a museum a-quar-ium.

*The Fish  
that Carries  
a Sword*

#### Nest Builders Under the Water

In the big glass pond of the aquarium in New York City, you can watch many kinds of fish build

#### The Walrus at Home



"The walrus belongs to the same family as the seal and sea lion, but it is three times as big, weighing as much as an ox. It has no fur but it has ivory tusks two feet long. It uses these to climb with, to pull sea weeds, to dig clams and to fight the polar bear."

# Young Seals at Play



Here you see two young elephant seals at play. As they get older their noses will develop into curved snouts, the shape of an elephant's trunk but shorter and thicker.

their nests. They behave so like birds that you half expect to hear them sing. The sun fish of our quiet rivers is a nest builder. A pair go together, as loving as blue birds, pull up stems, carry and sweep away pebbles and scoop a hollow in the sand. The eggs are laid there under a bower of water weeds, and watched. Often a colony of nests is formed, especially if meddlesome cat fish are about.

The stickleback, of both fresh and salt water, is the weaving oriole and spinning spider of the deep. The male fish that is as dainty as a trout, weaves a cylinder nest, open at both ends, of water stems and grasses, and binds it fast to a stout plant. He shapes the inside by pushing through and wriggling around, and glues everything together with a gelatin thread from his own body. He lets mama lay the

*Family Life  
of the  
Sticklebacks*

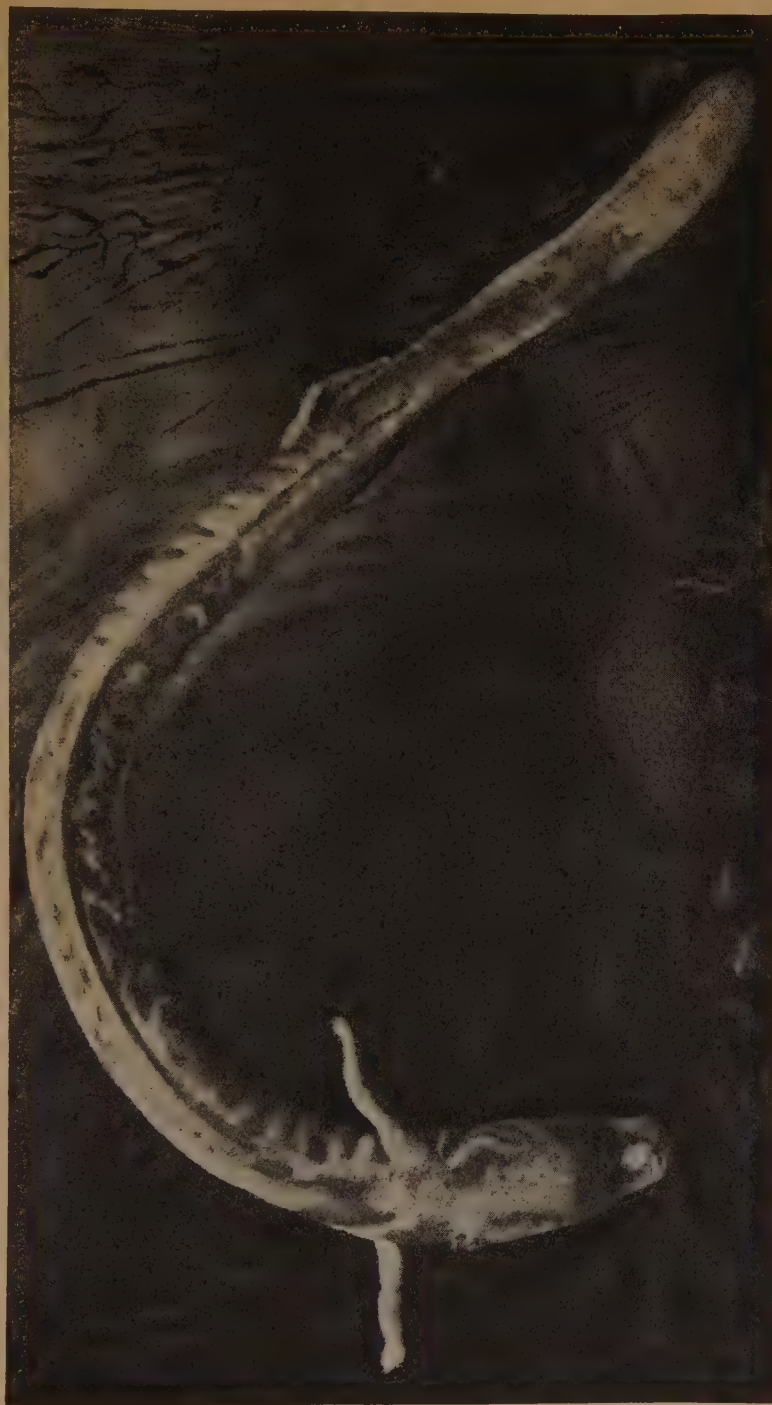
eggs, but she amuses herself while papa guards the eggs and babies for a month.

Out in the Atlantic Ocean is a big seaweed island called the Sargasso Sea. There the an-ten-nar-i-us, another spinning fish, makes a ball nest of weeds and gluey threads as big as a baby's head. The eggs and little fish are safe inside, while the ball buds and blooms and floats like a cork.

There may be air in it. One very curious fish nest is made of air-filled bubbles. The male fish comes to the surface and gobbles a lot of air. Then he blows it out, as you blow soap bubbles. He makes his own soap, and a tough mucus or spittal that last for days. The nest is a cluster of bubbles like a bunch of grapes. It floats on the water. When the baby fish are hatched

*Blowing  
Soap Bubbles  
for the Babies*

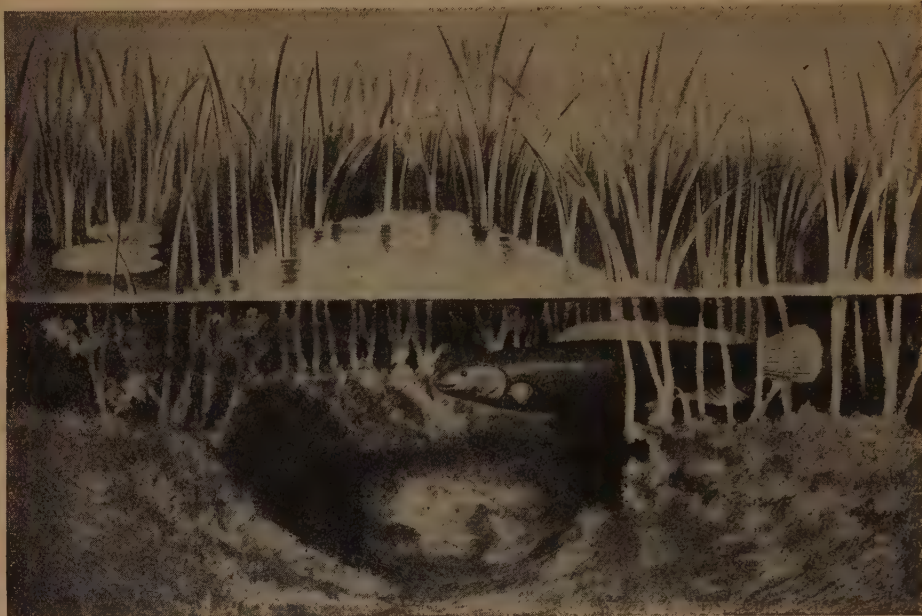
## A Fish Without Eyes



This is the proteus, a fish that lives in the pitch dark, underground rivers of the Alps. It has two dark spots on each side of its head where the eyes would be if it had them. It is almost white, with bright red gills and is shaped like a snake, you see. Its fins are more like rudimentary limbs.



## A River Nest-BUILDER



The bow-fin, an inhabitant of our own American rivers, builds a nest among the weeds for a nursery. Like the stickleback, the male fish plays nurse. Here you see him near the nest. He is about a foot and a half long.

they *eat the bubbles*. A water spider weaves a silk balloon, anchors it to a stout weed and then fills it with air.

*The Water Spider's Silk Balloon* There is a door at the bottom, but the water cannot push the air out and get in. The spider brings up her family here and in the winter closes the opening as if it were a diving bell and goes to sleep in it.

### Keeping Boarders Under Water

Did you ever find a red crab, as small as a garden spider, in an oyster stew? These tiny, soft-shelled fish, unable to defend themselves, take refuge in the pearl-lined houses of the oysters. They pay room rent by dragging food in with their claws, and live peaceably with their hosts. No doubt they could dig into the oyster's soft body, but they don't. Other boarders are not

so con-sid-er-ate. Sucker-like barnacles often cover the big, helpless whale; and the terrible *The Ugly Shark and His Pilot* shark has a little pilot fish to guide him, and to cling like a leech to his ugly, blue, scaleless back and chalk white stomach.

All the clumsy sea cucumbers have boarders. A big black one on the coral reefs off Florida has a six inch eel, as clear as glass, rooming in its air holes, and going in and out as it pleases, as if it had a latch key. The sea anemones, star fishes and many jelly-fishes "have timid little friends that run to them for shelter" when in danger.

But the strangest partnership of all is that of a sea anemone and the hermit crab. The crab gets a house by catching and eating a shell fish and then backing into the shell. On

## SOME STRANGE WATER ANIMALS

the point of the ribbed, tent-like roof, a sea anemone takes up its home. The crab feeds its companion by

*How the Crab  
Furnishes the  
Table*

pushing up dainty morsels with its claw. When the crab outgrows its house, and is obliged to move, it pries off its flower-like chum and helps it to move, too.

### Lamp Bearers, Electric Batteries and Ink Throwers

One of the prettiest things you could see, in crossing the ocean, would be a

*Little Fish  
that Carry  
"Matches"*

broad track of fiery foam in the wake of the ship. The light is made by billions of tiny jelly fish that you cannot see in the daytime. But they are full of the same phos-pho-rus that is on the heads of matches. After night-fall they make the sea shine; and many a weed draped cliff drips with molten gold in the moon-

*"Ocean Liners"  
Under  
the Sea*

light. Other fish have phos-phor-es-cent spots, as fire flies have under their wings. One carries a head-light and one hundred and six side lights, like an ocean liner. Some corals and anemones shine, and deep-sea crabs have stalked and flaming eyes like automobile lamps. The cyanea, a large

jelly fish, is a fiery green comet, with a disc and tail, a meteor shooting through the water.

You have heard of the electric eel, haven't you? It lives on the tropic coast of South America. A snake-like fish often twenty feet long, it can knock down a man with

### A Fish that Climbs Trees



This is the bommi fish of western Africa. It hatches its young in the water, but it can climb trees that grow along the river bank and it likes to lie for hours on shore or on the protruding roots of a mangrove tree, with its tail just dabbling in the water. Its forefins have developed into a kind of arms, as you see, with webbed fingers. The hind-fins have a sucker-like attachment for clinging. The bommi fish has no gills but it is thought that its tail, which is particularly well supplied with blood-vessels, in some way keeps the blood supplied with oxygen.

an electric shock. Under the tail are four batteries as perfect as the one that rings your door bell. There are nine varieties of electrical fish. One of them is the torpedo, found on



### The Sea-Serpent of the Fairy Tales



For a long time it was believed that the fabled sea-serpents of the fairy stories were a myth, but now it is known that there really were such monsters as these.

our Atlantic Coast. It has two hundred little batteries on its body. The spots look like oval inlayings of mother-of-pearl. The torpedoes often shock fishermen that try to catch them.

Another curious electric fish is the physalia. It is really a colony of animals, a jelly-like mass of blue worms squirming from a rich balloon-like body. Sardines, and other little fish that think those blue tentacles good to eat are killed by the shock and folded into the central stomach.

Here is the argonaut peeping out of its paper-like shell. The female builds this shell for her eggs by letting a gummy liquid ooze from her arms or tentacles. The argonaut has eight tentacles in all, and two green eyes. Its prevailing color is a beautiful deep blue but it changes like a chameleon to black, lavender, rose. It can creep along the sea floor or swim through the water by blowing water out of its mouth.

Cuttle fish, squids and the argonauts or shellfish sailors, are ink throwers. The devil fish is a squid. It has a central body all eyes and stomach, and ten snake-like arms. When the animal is attacked it darkens the water with a black fluid and escapes. The eight-armed octopus can drench a fisherman with jetty ink. But the shellfish make a beautiful purple or violet ink. Away over in the Mediterranean Sea are great numbers of them that are little royal purple dye spots. Centuries ago the people of the splendid city of Tyre used these mollusks to dye their purple sails, and the royal robes of emperors.

*The  
Ink Factories  
of the Deep*

### The Beautiful Argonaut





## Betwixts and Between

You know that frogs live partly in the water, partly out. Many animals do that—the beaver and muskrat, the seal and walrus, turtles and snakes, the crocodile and alligator. One of the oddest ones

*Mole, Duck  
and Fish,  
All in One*

is the duckbill, or water mole, of Australia. It has fur like a beaver, webbed feet and a bill like a duck. It lays eggs like a bird or turtle, is cold-blooded like a fish, and it makes a tunnel house in a bank like a mole.

These water-land animals are clever about solving difficulties. Eels wriggle across a marsh to distant

pools. A New Zealand goby leaves the sea to catch clams on the beach. Crabs in the West Indies march

*Water People  
that Travel  
on Land*

overland in big armies, in the night. It really is no queerer for a fish to walk on its fins through grass than for a land-nesting bird to dive, swim and feed under water. But it seems queerer, and it makes us all think:

Where do furry animals, feathered birds, scaly fish and little boys and girls begin to be, and where do they leave off and begin to be something else?

"That," as a wee lady baby said, "is the puzzle of it."

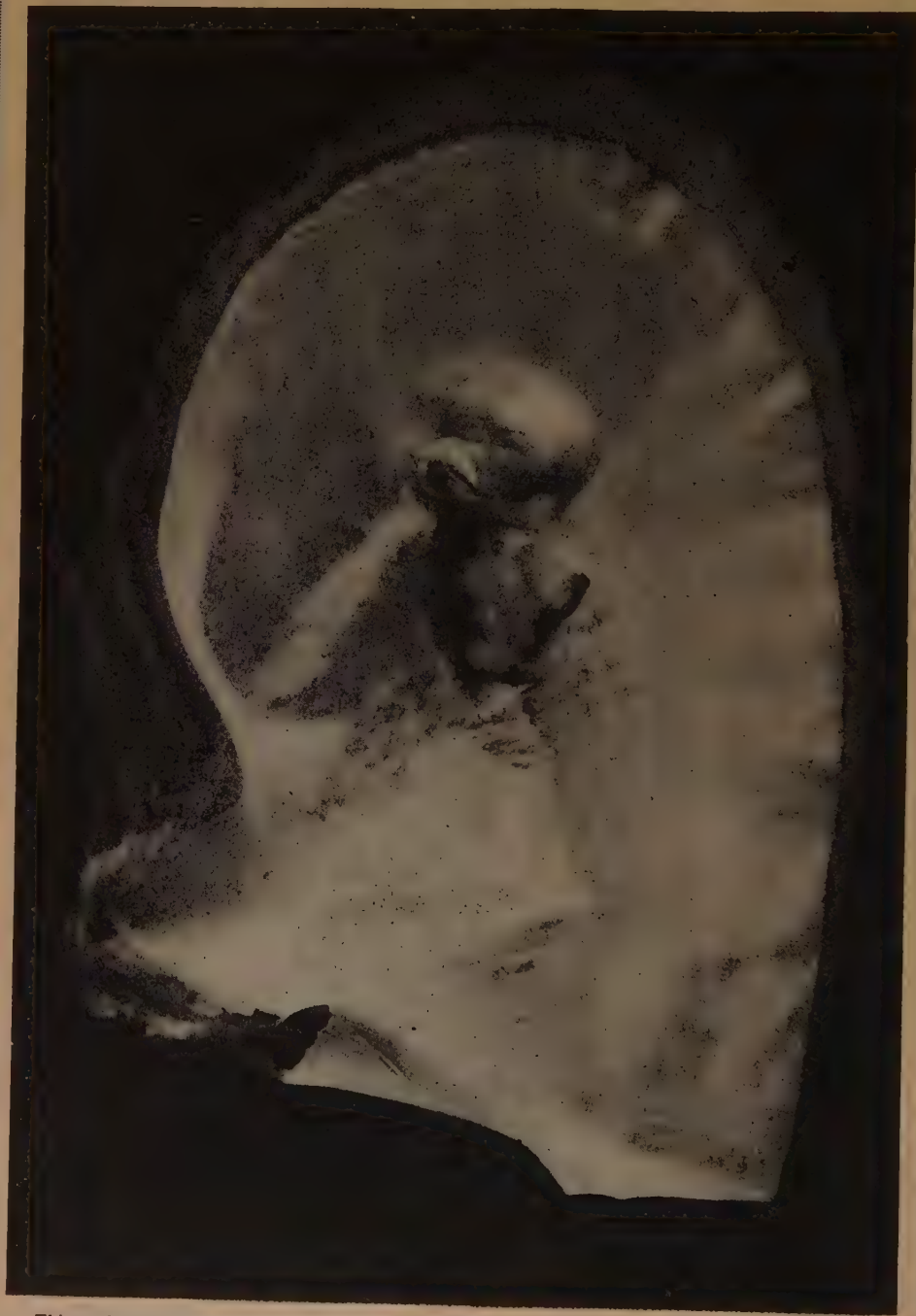
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## The Whale

THE inhabitant of another planet descending towards ours in a balloon and surveying it from a vast height, would say to himself, "The only creatures that I can discover there are from one hundred to two hundred feet long, their arms are only twenty feet long, but their superb tail, thirty feet, magnificently beats the sea, and enables them to advance with a speed and a majesticease which make it very evident that they are the sovereigns of that planet."

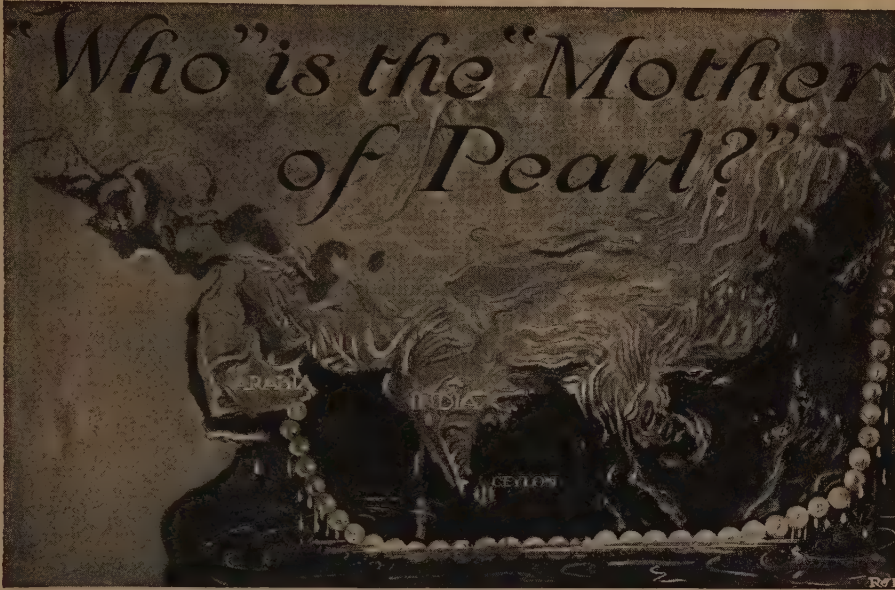
And by and by he would add: "It is a great pity that the solid part of that globe should be deserted, or at best peopled only by creatures so small that they are invisible. Apparently the sea alone is inhabited and by a kind and gentle race. Here the family is held in honor, the mother nurses and suckles her young ones with tenderness, and although her arms are very short she contrives during the raging of the tempest to protect her little one by pressing it to her vast body. —*Michelet: The Sea.*

## The Pearl in the Oyster Shell



This curious pearl was found in an oyster shell off the coast of Australia. It is two inches long. Most pearls vary in size between that of a pea and a mustard seed.

# THE HOW AND WHY OF COMMON THINGS HOW PEARLS ARE FORMED



The "pearl coast" of Asia might well be bound with a rope of lustrous, white pearl beads. Divers, yellow and brown and white, have been bringing up the ocean gems for centuries.

**P**EARLS are found in the shells of sea and fresh water oysters and other shell fish. They are made of a limy secretion of the animal, the same material that lines the shells. This nacre or mother-of-pearl is formed of thin plates, or skins, one over another, very smooth, semi-transparent, and with a wonderful play of colors like the opal. Sometimes a grain of sand, or other foreign body gets inside a shell and scratches the soft body of the oyster. If unable to dislodge the particle, the animal encloses it in nacre. A few pearls have been found two inches in diameter, but

most are the size of peas or mustard seeds. They are round, button shaped or pear shaped, and of all colors from jet black to pure white, with all shades of pink, lavender and smoke. Next to white in beauty are those that are rose-colored. The value of a pearl depends upon size, shape, color, luster and freedom from flaws. Because it is hard to find any two exactly alike, matched pearls in a necklace have an added value. Fine black pearls are found off the coast of Lower California, and fresh water pearls in the Mississippi River and in its tributaries, and in several European rivers.

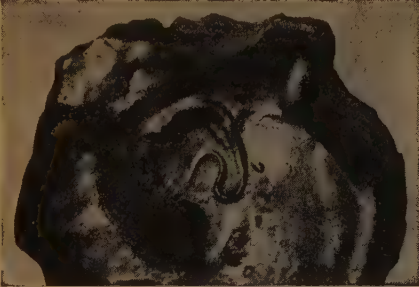
*Trouble in  
Their Little  
Insides*



The mother-of-pearl linings of shells are used for making buttons, pen and knife handles, and in many ornamental ways.

The greatest pearl fisheries in the world are in the Persian Gulf

#### In a Prison of Pearl



This picture shows how a small eel-like fish, called the ferasfer, which found its way into an oyster shell, has been covered up with the nacre and so enclosed in a "prison of pearl."

and off the Island of Ceylon. The pearl-bearing oysters are brought

#### *The Business of Diving for Pearls*

up by divers. Our illustration shows one of these divers on his way to work. You notice he is holding his nose just as boys sometimes do when they dive. But he is holding it with what looks to be a clothes pin. These nose clasps are worn by the Arab divers in the Ceylon oyster fields. They are made of flexible horn. On his right foot you see the diver has an oval-shaped stone with a kind of stirrup attached to it through a hole in the stone. Into this stirrup he fits his right foot while his left rests on the basket he is taking down with him to gather the oyster shells, just as you would take a basket to gather blackberries. This basket is made of rope.

#### A Deep Breath and Down He Goes

Just before he starts down the diver draws a deep breath—

#### On His Way to Work



enough to last him on his journey down and up again—much as a camel takes in a good supply of water before he starts across the desert where he will not get a new supply for some time.

ply of breath is getting too low for safety, he pulls the rope as a signal and is hauled up by his helper in the boat above. Our sea divers work in much the same way, but not with such crude devices.

## Queensland Pearls—Exact Size



Here are some Australian pearls of great size and beauty. The picture shows the exact size of the pearls. Notice that some of them are not round, but egg-shaped.

As soon as he gets down he slips his foot out of the stirrup and hurries over the bottom just as fast as possible, tugging loose all the oysters he can and throwing them into the basket.

Just before he feels that his sup-

The diver goes down every five or six minutes. Just before each dive he dries his body carefully so that he will not take cold and get the cramps.

How long do you suppose a diver can stay under water? If you should

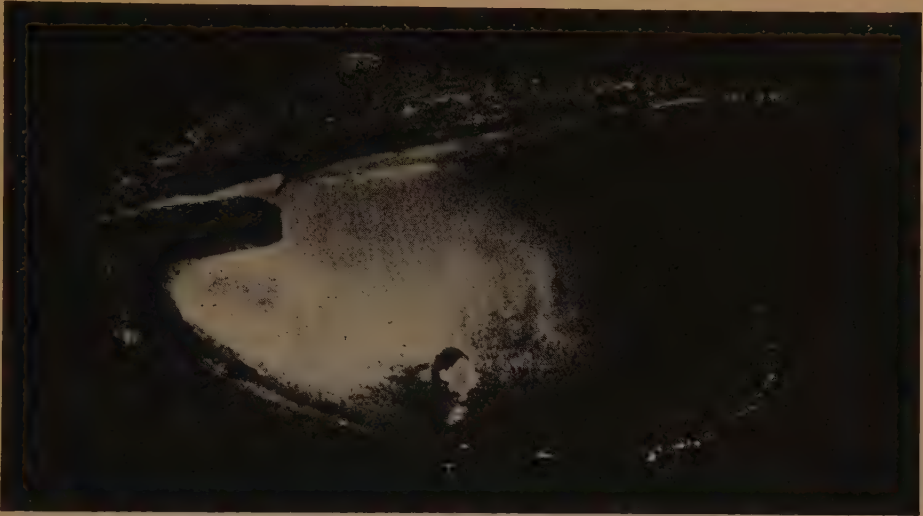
## At Work in the Pearl-Oyster-Beds



Here you see two kinds of pearl divers working side by side—the naked natives, who stay down hardly more than a minute, and the divers in regulation diving dress. You can read all about them in our story about divers. Both are using iron scrapers to dig the oysters from their resting-places. Notice the electric lamp held by one diver.



## How the Oyster Makes the Pearl



"Mother-of-pearl is formed of thin plates, or skins, one over another, very smooth, semi-transparent, and with a wonderful play of colors, like the opal. Sometimes a grain of sand or other foreign body gets inside a shell and scratches the soft body of the oyster. If unable to dislodge the particle, the animal encloses it in nacre."

read the works of the old travelers you would think that the diver could stay under water an "awful" time. The farther back you go in these old writers the longer they stay. For example, a traveler who wrote a few years after our Revolutionary War, told of a diver who could stay under six minutes. But back in 1667 a report of the Royal Society of London tells how these pearl men of Ceylon could keep under a quarter of an hour. If you go back as far as the travelers



of 1336 you find those who say that "some remained down an hour, others two hours."

This does not mean that the travelers and scientific men of other days were untruthful. It simply means that scientific men have learned to be much more careful about what they write—not taking mere rumors, or working on theory alone, but investigating carefully.

The fact is, these pearl divers can stay at the bottom from a minute to a minute and a half.

## "Spice and Other Things Nice"

**WE USE** a great many things to give pleasant flavors to food. They have no food value, and we could get along very well without them. But we like them so much that vessels sail and steam away to all sorts of queer, out of the way corners of the earth to get them.

Pepper is the seed of a climbing vine that grows in the East India Islands, and on the coasts. You can buy

*Different Kinds of Pepper*

black or brown seeds that are as large as a small pea and grind your own pepper, if you have a spice mill. White pepper is made by treating the seeds in special ways when they are being cured. Red pepper, or "cayenne," or "paprika" are altogether different. They are made from the dried seed pod of the chilli that grows in Guiana, South America. They are something like the pepper plants of our gardens, only much hotter.

The nutmeg that is so good in doughnuts, custards and apple pies, grows on a tree, something like a pear tree. The fruit is as big and

pretty as an apricot. When the pulp is washed away a single

*For Dough-nuts, Custards and Pies*

spicy, oily seed is found wrapped in a bright red skin. This skin is removed, dried separately and called "mace." The nutmeg tree is grown in orchards in the East and West Indies, and in Brazil.

Cloves are not seeds, but flowers. Wouldn't you like to smell a clove orchard in bloom in Zanzibar? The flowers are tiny crimson, four-petaled blossoms on a short stem. Dried in the wood smoke, they

turn brown and tough. Cinnamon is the bark of a big tree, a native of Ceylon, but grown in many hot countries. The thin outer bark is peeled off, every year, like birch

*Where the Clove Orchards Bloom*

bark, and dried in rolls. Ginger is a root, or buried stem of a low, annual plant. The best in our market comes from Jamaica. When the tops die the ginger "root" is dug up, cleaned, dried and ground. Some is made into an extract by dripping alcohol through it. The Chinese preserve ginger and candy it. Doesn't your mama like a tin box of Chinese ginger for Christmas? Mustard is made from the seeds of the mustard plant that grows wild all over America and Europe, and is cultivated. And did you ever eat "curry" in a chicken stew? Curry powder is made of a mixture of queer spices—turmeric, poppy seeds, curry leaves, anise seeds, mustard, chilli peppers, mace, saffron and many other things all ground together. India has forty different kinds of curry powders.

Vanilla is a bean that grows in long pods, on an air plant vine, in tropical America. The vine is pretty, with waxy stems and leaves, and

*Vanilla and Other Extracts*

slender pods as long as a banana. The dried beans are ground, and alcohol is filtered through to make vanilla extract. In the same way extracts are made of wintergreen berries, peppermint leaves, the rinds of lemons and oranges, the seeds of bitter almonds and pistachio nuts, peach kernels and other fruits.

# IN THE GREAT WORLD OF NATURE BEES

## The Busy Honey Bee

A BEE LINE

"When they had all they could carry the bees circled straight upward and made a 'bee line' for home, even if a mile away. How they did it is a mystery. They dropped to the hive, never missing the small opening by an inch."

*"The Queen was in the parlor,  
Eating bread and honey."*

MAYBE it was only honey. But she did not like being shut up in her parlor, all alone. She was a pretty, long-bodied queen bee who had just crawled from her pupa case cradle. The parlor was an inch high, a third of an inch wide and pear or bottle-shaped. The walls were of varnished wax, with no opening. It was as dark as your pocket in that parlor. There

*The Royal  
Prisoner in  
Her Parlor* was no doubt about its being a prison, for the queen had turned 'round and 'round in it and had found neither a window, nor a thin place that she could break through. Suddenly a hole appeared in the ceil-

ing. She pushed her head up, and put her long trunk or licking lip through the hole.

"Squeak!" she complained, in a piping voice. "Please, I want to get out."

A drop of honey was put on her lip by a maid of honor, one of a circle of worker bees that guarded the hole. Another and another drop trickled down until she had had enough. Then she cried out again.

"Hsh-sh-sh!" She was caressed and soothed by the antennae, or feelers of her anxious attendants.

"Squeak, squeak, squeak!" The food had made the little queen stronger.



## The Three Classes of Society in the Bee State



Here are the ruler, laborer, and gentleman of leisure in the bee country. *A* is the queen bee and mother of the hive. Her business is the laying of eggs. *B* shows the worker bee, an imperfect female. These members of the bee community do all the work of the hive and really control the affairs of state. *C* is the drone or male bee. He is a wealthy idler, kept in luxury by the workers but also killed by them when summer is over and the food supply must be hoarded.

"Oh, please be quiet, your majesty. The old queen will hear you and come to kill you."

### What a Cross Old Queen!

"What's all this noise about?"

The old queen bustled up, fluttering her small wings and dragging her long, egg-filled abdomen behind her.

I laid the eggs from which every-one of you were hatched. Just let me get at that little upstart!" A dozen

*Queen Bees  
Have Such  
Tempers!*

of the guard of honor pushed her, nipped her legs, pulled her about and got in her way. They did not hurt her, for they loved their old queen, but she was forced back, angry and baffled. The new queen

### How Bees Do without Electric Fans

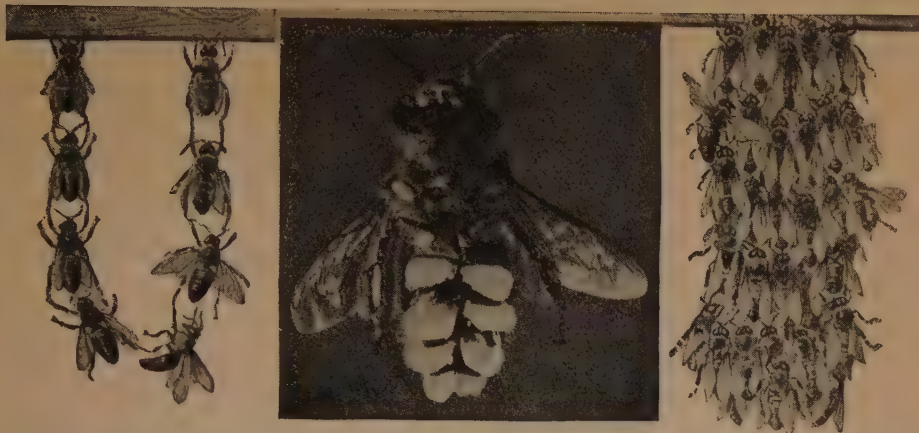


These bees are at the entrance of the hive fanning the air with their wings. "The air inside a dark, close beehive is as sweet and fresh as the air outside" because the bees keep it in motion. This is the only work that the drones do and they only help the workers at it. In hot weather a regular army of bees work in shifts at the fanning, relieving each other from time to time.

"*Fe, fi, fo, fum!* I smell the blood of a rival. So you are tired of your old queen? Ungrateful children!

was angry, too. If the old queen wanted to fight, why, she was ready for the fray.

## In the Bee's Wax Factory



The first picture shows a festoon of workers clinging to each other while the wax-forming process goes on. They hang like this for twenty-four hours at a time. On the right is a larger mass of wax producers. A high temperature is necessary for the formation of the wax, and for this reason the bees cling together in a big bunch just as children cuddle together in bed on a cold night. The center picture shows a worker producing wax. You can see the plates of wax appearing between the segments of the bee's abdomen. A worker bee must eat from sixteen to twenty pounds of honey in order to produce one pound of wax.

The whole hive was excited. The temperature suddenly went up to over a hundred in the shade, for the blood of angry and excited bees gets hot. The lazy blunt bodied male drones went out to loaf on the roof in the sunshine. Some little worker bees came to the low door and fanned the air into the hive with their wings. Inside, other bees fanned bad air out. Such a humming noise as though electric fans were whirring!

Things quieted down, but all work was stopped. The prisoner cried piteously. The maids of honor petted and fed her through the hole. The old queen sulked and made rushes, and darted about trying to find other royal cells. If there were any, they were guarded. By and by she brightened with an idea.

#### The Old Queen Resolves on Exile

"There are too many bees in this hive anyhow," said the old queen,

angrily. "Who will follow me into exile to found a new colony?"

That was sensible. It was the old queen's duty to go when the hive became crowded, for a young, inexperienced queen who could not even lay eggs, could not head a new settlement. Immediately a great number decided to go with her, and began to pack up. "Packing up" for bees is breaking into honey jars and gorging themselves.

It was a warm, sunny day in June. Led by the old queen, thousands of bees boiled out of the hive and gathered on a low bush or branch—a regular congress of bees. Very likely they got together to talk things over. Suddenly a cloud of smoke stunned them, and they dropped into an empty hive held under them by the bee keeper.

Such a roomy, brand new palace as they woke up in! They explored every corner of it. Some began to carry out dust, vigorously cleaning house. Others flew away and came



### Labor-Saving Machinery for the Bees



To give the bees a good start in their housekeeping, rolls of wax are run through the roller press machine, which gives them the shape of honey-comb. The rolls are kept moist and soft in the tanks, as you see, and a series of rollers makes an indentation where each cell is to be. Then these honey-comb sheets are cut up into strips to fit the hive frames. The walls of these artificially made cells are about half as high as they are in the finished comb, so the bees have to add more wax to the cell walls. The artificially started combs are an immense saving of labor for the bee, and of money to the bee-keeper, because the bees can put in more time gathering honey than when they have to build the whole comb.

### At Work on the Honey Warehouse



"The other bees laid a foundation and began to build a comb. Little knots of bees worked all over the foundations at once, tumbling and crawling over each other. They were so crowded together that you could not tell what they were doing. Perhaps some acted as hod-carriers and some as masons. Sketchy six-sided cells began to rise."



## Two Kinds of Nurseries



At the left the bees are building comb in which the queen bee will lay drone eggs. See how much larger and thicker-walled the cells are than the ones in the comb on the right, which will be the early home of worker grubs. The bees are seen crossing from one comb to another, at work on both at the same time, yet never building drone cells and worker cells in the same comb. At the right the living festoon of bees is busy producing wax.

## How the Bee Carries Her Baggage



The bee has a very convenient way of carrying her baggage. The bee at the right is carrying a big bundle of pollen on the thigh of her hind leg. In the picture on the left the pollen has been removed to show the "pocket" or hollow in which it rested. Notice the stiff hairs that grow all over the bee's leg. These collect the pollen grains as the bee enters the flower, and the bee brushes them from her legs with her feet and rolls them into a ball which she presses into her "pollen pocket." The pollen pocket is also supplied with stiff hairs all pointing inward. They hold the pollen in the hollow after the bee has once placed it there.

back, so sticky with resin from pine cones and leaf buds, that they had to be scraped clean by friends. This resin was used to fill up cracks and holes and to varnish the insides of frames. Other bees went right up to the ceiling and hung in a cluster

*Getting the  
New Place  
Ready*

like bats, motionless for hours. Thin wax oozed in scales from the rings of their bodies. When they dropped at last, they pulled off these wax scales and chewed them. Each bee nibbled all around the edge of a wax scale, as you eat a cookie. They bit and chewed and mixed a frothy liquid with the hard wax and made a creamy, soft mass.

With this other bees laid a foundation and began to build a comb. Little knots of bees worked all over

the foundations at once, tumbling and crawling over each other. They were so crowded together that you could not tell what they were doing. Perhaps some acted as hod-carriers, and some as masons. Sketchy six-sided cells began to rise on each side of a partition that was started across the middle of a frame.

Before the cells were finished, the queen began to lay eggs in them. In many small cells she put eggs that would hatch into worker bees. In a few larger cells she put drone eggs. A whole frame was filled up with brood or nursery cells. Then another frame was filled with deep cells for storing honey and pollen. Those eggs would begin to hatch in three days, and baby grubs must be fed,

*Laying  
the Eggs  
in the Cells*



## How the Bee Drinks through a "Straw"



The "tongue" with which the bee sips up honey from flowers is really not a tongue at all, but a lengthened-out lower lip. The picture shows you the tip of it. When the bee wants to take a big swallow, she brings all three points together to form a hollow tube. It's like drinking lemonade through a straw, isn't it? When the last drop in a flower's cup of sweetness is to be drained, the fine hairs on the tip of the middle prong mop up the liquid and it is sucked up by that part alone, which is also tubular in form.

Each of the bee's six legs has nine joints. In the illustration at the right you see the joint on one of the hind legs just above the pollen basket. It also shows you how well supplied with short, bristly hairs the legs are.

so a part of the hive went out to forage for supplies.

### Marketing of Bees and Their Baskets

The bees gathered honey and pollen at the same time. They poked their long, licking lips into flower cups and swallowed the nec-

tar down to the first stomach or crop.

Then they brushed their hairy bodies and legs across blossoms. Sometimes they wallowed in the pollen or ran back and

### The Bee's Brush and Comb



This is the arrangement on the bee's forelegs by which her antennae or feelers are kept clean. The white projection on the upper part of the leg fits into a cavity in the part below the joint when the leg is bent, so that the whole forms a little ring lined with stiff hairs. The bee puts her antennae in the cavity, then bends her leg at that joint, pulling the antennae back and forth. The hairs brush the antennae clean of any dirt that may be sticking to them.

forth to cover themselves. With their hind feet they scraped the pollen off, gathered it up into little pellets and poked them into the pockets or pollen baskets inside their hind legs.

They were in all sorts of danger. When standing on their heads in flower cups, wasps and hornets stung some of them; woodpeckers and swallows gobbled a few up; field mice made meals of them; and



# How the Bee Works Her Flying Machine



The bee has four wings on each side, but when they are raised for flight they automatically lock together, forming two large wings. The under wings have a row of hooks which catch hold of the flange or rim on the upper wings. The picture shows the left wings of a bee hooked in this way, as they look when the bee is flying.

even hens snapped them into two. But beside the two, big compound eyes on the sides of their heads, the bees had three little eyes on the top, to see above them. Their antennae too, are fingers, ears, and noses always in motion to get news of alarming sounds, odors, and prowlers; so Miss Honeybee was always on the alert and she had many hairbreadth escapes.

The Bee's Sting



With all man's knowledge and experience in warfare he has never made a weapon half so dangerous in comparison to its size as the bee's sting. Here you see the little instrument magnified twelve times. There are three sharp little lances (only two of them show in the picture), edged with jagged barbs. Because of these barbs the "stinger" works its way into the flesh, and cannot be drawn out again by the bee. The sac at the end of the stinger is the gland containing the poison that makes the bee's sting deadly to other insects, and very painful to the bare feet of little boys, sometimes.

## A Queer Way to the Front Door

When they had all they could carry, the bees circled straight upward and made a "bee-line" for home, even if a mile away. How they did it is a mystery. They dropped to the hive, never missing the small opening below by an inch. Inside they emptied the leg baskets, and brought the honey up from their crops, much as a cow brings up her

## The Baby Bees and Their Nurses



Whatever mama and the nurses may think, you can't say a baby bee is pretty, can you? I mean when he is still a grub, like that shown in the picture. Yet the most beautiful baby in the world was never tended more carefully, more lovingly, than these pudgy, white, legless grubs. They are so helpless that they would surely die if they were not cared for. They hatch three days after the eggs are laid and are fed on bee bread, a mixture of honey and pollen. The grubs grow so fast on this diet that in five days they are full grown, and fill their cells, which are then sealed up by the nurses. Then the grubs change to chrysalids, as the second one is doing.

The queer-looking things in the right-hand picture are bumble bee chrysalids. In the first illustration, you are looking at the under side of the chrysalid. Notice how the legs, tongue, and antennae are folded. At the right is a back view of the same chrysalid. It shows you how the wings fold downward. Fourteen days are spent in this state before the full-grown bee crawls out.

cud. When a little wax jar in a comb was full of honey it was sealed with wax, to be opened when needed.

In three days there was baby nursing to do in the new hive. Perfectly helpless, the legless, white grubs lay coiled, each in its tiny cell. There it was fed with bee-bread of pollen and honey, by the nurse bees. In six days

*What a "Bee-Hive" Really Is*

the larvae had shed their skins three or four times and grown up to fill their cells. When they stopped eating, the nurse bees sealed the cells with thin wax. The grubs spun their cocoons. In eight or nine days the baby bees broke prison and crawled out—twenty-one days from the time the eggs were laid. A drone took twenty-five days, a queen only sixteen. But a queen was made

from a worker egg, only when one was needed.

The baby bees were pale in color and small. They did not know how

## The Queen's Cradle



Here is a queen cell alongside of some ordinary worker cells. You see it is much larger and differently placed—with the mouth opening downward—and it is pear-shaped instead of six-sided. The wax composing it is also a little different; it is coarser than that used for the other cells. A queen cell takes one hundred times as much wax as a worker cell.

to use their wings or even to feed themselves. Nurse bees licked them all over, as a cat does her kittens. They fed them from their

*The Baby Bees and Their Nurses*

own mouths and cleaned out the cells for new eggs. For a couple of weeks the young bees stayed in the hive, at cleaning and nursing duty. Perhaps they exercised their wings by fanning the air. Some bees seemed always to be at that ventilating work. The air inside a dark, close beehive is as sweet and fresh as the air outside.

On dark and rainy days, when all the bees were at home, the hive hummed with this constant fanning.

The bees were peaceful among

## Cousins of the Honey Bee



These are bumble bees, heavier-set and burlier than their relatives, the honey bee. On the left is a queen bumble bee, at the bottom is a drone, and on the right, a worker. The pictures show them one-third larger than they are in real life.

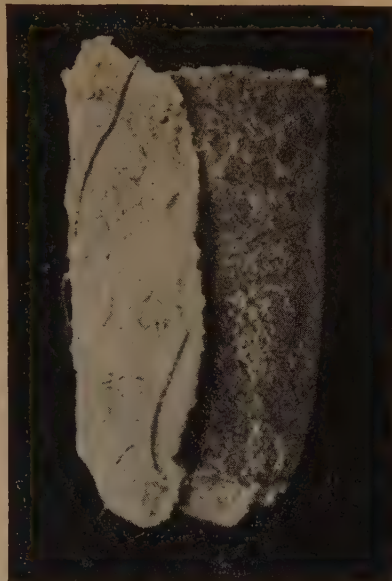
## Mother Bumble and "Her Chickens"



Bumble bees do not build up comb like the honey bees, but store their honey in large open-mouthed cells called "honey pots." See the higgledy-piggledy manner in which the cells and honey pots are grouped—quite different from the neat comb built by honey bees. The queen bumble bee is a more devoted mother than the honey bee queen, for she broods her children as a hen does her chicks. For this reason the brood cells are built in irregular groups around a central trough in which the queen lies. The warmth of her body helps to hatch the eggs.



## Upholstering Bees



## The Leaves of Your Rosebush and Where They Go

These rose leaves look as though some one had been at work with a fairy cookie-cutter, don't they? See how neatly the little round pieces have been cut from them. The little fairy that did it was a bee. And what do you suppose she was making? A cradle! Here is a picture of it on the right. First she makes a long hollow cavity in some rather soft substance like decayed wood. Then she cuts a large oval piece of leaf to line it with. This is the outside of her cell. She



flies back to the same rose bush again and cuts three or four smaller, semi-circular bits of leaf. These she rolls into tubes and fits inside the leaf-lined cavity. Her nest is then ready to be stored with food; so she fills it almost full of honey and pollen. Last of all she lays an egg in the cell and closes the top with several more round leaf-cuttings.

In the lower picture a decayed log has been split to show several shafts which the leaf-cutting bee tunnelled out. Two of them are filled with layers of leaf-upholstered cells, one above the other.

## Carpenter Bees



A big bluish-black bee that sometimes frightens you with its loud buzzing is called the carpenter bee. Here is a picture of the violet carpenter, a species that is common in Europe. It burrows tunnels in wooden posts, and divides them into chambers. An egg and food for the grub when it is hatched are put in each chamber. The artist has drawn a cross-section of a post used for a home by some carpenter bees to show you how they live. In the upper right-hand cell a bee is at work storing food. Below it you can see the food and egg in the closed cell. The second chamber in the longer tunnel contains a grub feeding and below it are two cells holding chrysalids. The upper one shows you the chrysalid from the back, the lower one from the front.



themselves, even affectionate. In passing each other they touched their antennae. With these delicate feelers they caressed the queen and the baby bees. But if a stranger entered

*But Strangers Are Not Wanted* the hive—a hornet or wasp, or bee moth to lay its eggs, or robber bees to steal their honey—the worker bees fought the intruder. A strange

around the caterpillar's head in a collar, so all it has to do is to twist and eat all around itself.

If no old queen is in the hive, the young queen is freed at once. How she is watched and fed and petted! In a couple of weeks she goes for an airing. She flutters about her home so she will know it when she returns, for she must take one journey. She

## The "Death's Head" Burglar and the Bees



Do you see how the Death's Head moth got his name? He's a burglar, too! If the bees aren't on guard, he comes into the hives and feasts on the bees' store of honey. You say, "Why doesn't the bee use that terrible stinger on him?" That's the strange part of it. The Death's Head moth makes a squeaking noise like the bee queen and, while I suppose it puzzles the bees a good deal that a queen should look so much like a moth, they don't attack him. But I'll tell you what they do do. When they know there is one of these night prowling robbers in the neighborhood, they build walls of wax from the entrance into the hives so small that bees can come in and out, but the moth can't. That fixes him!

queen was killed by the queen of the hive, or a crowd of worker bees formed a ball around her and smothered her to death.

The queen bee lives three, four, or five years. Sometimes when old she leaves the hive and wanders away to die. Then if a young queen

*Sorrow When Queen Dies* has not been provided, the bees are distracted.

For a day or two they go about frantically looking for their queen. At last they return, select a newly hatched worker grub, tear down partitions to make a larger cell for it, and then feed the grub on royal jelly. This food is not as sweet as ordinary bee-bread. It has acid in it, and it makes the grub grow fast and big. Food is put all

goes straight up, out of sight.

The worker bees wait for her anxiously. She may be captured by a bird, lose her way, or make a mistake and try to get into the wrong hive. When, at last, she drops, exhausted, she is hurried in, fed, waited on, caressed. In a few days she begins to lay eggs—hundreds of them, a thousand or two in a day in the honey season. The hive is a humming city of busy workers.

## What the Bees Do in Winter Time

Late in summer, when the honey flowers are gone and bees are obliged to get what food they can from decaying fruits, the workers kill the drones. They kill all the drone grubs and eggs, so there will



be no mouths of idlers to feed over winter. The queen stops laying eggs. The bees surround their queen for warmth and hang in a bunch from the ceiling. On warm bright days they come down to gorge themselves with honey. A few may crawl out to stretch their legs and wings. But they go back and go to sleep again. A good beekeeper who takes all the honey from a hive puts syrup and farina in for winter food.

*A Living  
Blanket for  
the Queen*

In the spring a bee colony is

always small and feeble, but the queen begins to lay eggs again and every kind of work is taken up, so, in a month, the hive is swarming again. When the hive becomes overcrowded, a new queen is bred and the old one leads a swarm into exile. This may happen several times in a season. The workers do not seem to ask the queen's permission or advice. It always surprises and angers her when she hears the piping voice of her rival:

"Please! I want to get out!"

## The Bumble-Bee and the Clover

*Came a roaring bumble-bee,  
Pockets full of money.  
"Ah, good morning, Clover sweet,  
What's the price of honey?"*

*"Help yourself, sir," Clover said,  
"Bumble, you're too funny;  
Never Clover yet so poor  
She must sell her honey."*

ANONYMOUS





**This Butterfly Plays It's An Owl!**

See those two big eyes? They are two spots in the wings of the huge Caligo butterfly of the tropics. When it stops to rest it turns with its head down, with those two eye spots turned up, and the humming birds that eat butterflies are afraid because they think the butterfly is an owl and will eat THEM!



# The Butterflies and the Moths



RSK

**W**HAT is the difference between butterflies and moths?

Many grown people as well as the children would like to know that. Some think that all the gay little creatures with four, painted wings, fluttering and flying and hovering over flowers, are butterflies; and the dull-colored, dusty "millers," moths. But there are many plain little butterflies and many big, gorgeous moths.

But the two are so nearly related that it is hard to tell them apart. They belong to one family of just two members. It is as if there were only two varieties of birds—thrushes and owls.

That's it! Butterflies are the robins, blue-birds and brown thrashers of their family, sipping honey-dew and visiting each other

by day, and sleeping at night. Moths hide in shady places with their big eyes shut, in the daytime, and prowl about in the dark. So it is true that most of those you see on the wing in the sunshine are butterflies; but there are

also a few day-flying moths.

To make sure "which is which" watch one when it settles. If it balances its lifted wings, or folds them together above its back, making a tiny sail, it is probably a butterfly. Moths droop their wings and then fold them close to the body. But look at the antennae, or "feelers." A butterfly's antennae are slender, and have a knob or club on the end. The antennae of the moths are tapering, spurred, hooked, hairy or beautifully feathered, but never knobbed.

The butterfly's body is short and slim, often like a polished, ornamental hinge for the wings to open and shut on. The hind wings extend beyond the body. The moth's body is longer and heavier. It is often as fat, furry and as beautifully banded as the bumblebee's.

## The Beautiful Life of a Day

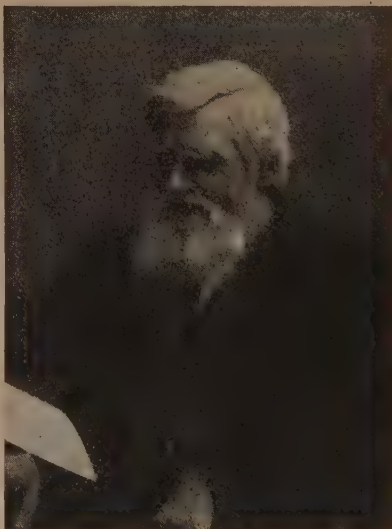
There is no other living thing with which nature takes more pains than these little winged idlers of sun and moonlight.

## A Butterfly Whose Beauty Gave A Great Man the Headache



This butterfly measures seven inches with wings outstretched; the male is velvety black with fiery orange markings. The female is lighter—brown with gray and dull yellow spots. It was discovered on Bachian Island, in the Dutch West Indies.

You wonder why she does it for most of them are meant to live for only a few days. They have no work to do, as the bees and ants have—no nests to build and babies to feed, or food to store up. They live just long enough for a little pleasure; a dainty draining of flower cups and the laying of eggs. If you see them all summer long it is because new ones are always coming out of their pupa cases.



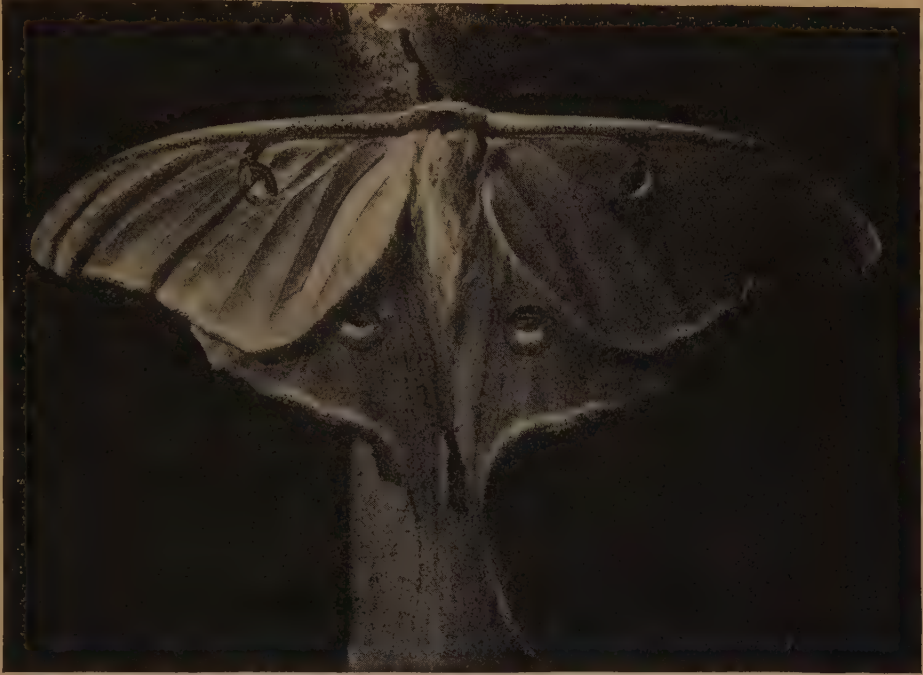
Alfred Russel Wallace, the great English naturalist, was so excited when he discovered the gorgeous Croesus bird-wing in its native home, that he had a headache the rest of the day. Great men in every line are like that—they are as enthusiastic as children about the things that interest them.

As with flies there are several generations in one season.

On any sunny day, you can see swarms of the big brown, black-bordered, cream-spotted milkweed butterflies. You can see the delicate angel wings, the mottled tortoise shells, the yellow and white "sulphurs," the nattily cut swallow-tails, and the lively "skippers" that jump about like fleas. You can see many "blues" and



# "That Silvery-Green, Moon-Spotted Ballroom Belle"



This is one of the most beautiful of American moths. It flies at night and is called the luna (which means moon) moth. It lives in the woods on hickory, sassafras and sweet-gum trees. The long, slender, curved tails of the wings and the straight line at the front give the moth an unusual and graceful shape, but its coloring is its greatest charm. Like a little girl's party dress, it is tinted with the daintiest of shades. A background of pale green shades off to yellow on the edges except in front, where the wings are bordered with purple. Transparent circles, like lace medallions, are rimmed with yellow, pale blue and black. Add to this the delicately branched antennae, like slender, young fern fronds, and you have a creature as fair as Luna, the moon goddess, for whom it is named.

"coppers" that glitter like metals. You can catch them only with a butterfly net for, like the spider and the fly, they have compound eyes, and can see all around them.

Moths have owl's eyes, that stand out from the sides of the head like jetty shoe buttons. No doubt they can

## Some Strange and Beautiful Wing Markings



This is the "old lady moth." When her wings are closed, as in the picture, she looks like a little old lady in an old-fashioned, fringed Paisley shawl in dull, quiet colors.

see, in the dark, the rose and gold bandings, and pretty crescent and moon spots on each other. There are only a few hundred varieties of butterflies, but several thousand moths, so there must be many more moths abroad at night than there are butterflies by day. A great many are



## Face to Face with Mrs. Moth



The head is a flattened globe, broader than it is long. The bright, compound eyes are on the sides, and between them the feelers that are fingers, noses and maybe ears. The brain is mostly a pair of optic, or eye nerves. No wonder a moth or butterfly is hard to catch!

## THE BUTTERFLIES AND THE MOTHS

attracted by bright light, and fly around street lamps. But the fine, large ones seldom come near houses. The big hawk moths visit the evening primrose for sips of nectar. You can coax moths out of trees and bushes by smearing tree trunks with molasses and alcohol. That will make them too stupid to move when you flash a dark lantern on them. Then you may see the polyphemus of the velvet brocade gown; or that silvery green, moon-spotted ball room belle, the luna moth.

### Raising Moths and Butterflies

But these fluttering little creatures won't stand still long enough to be

### As Beautiful as Birds' Eggs



"Under a microscope you would find butterfly and moth eggs as prettily colored and marked as birds' eggs, but of many odd shapes. Some are sharp cornered, ribbed and spiny. Each has a papery shell."

studied. Why not raise a few? In the story of Silk you can read about how Chinese and Japanese children watch the silk moth eggs hatch, feed the larvae on mulberry leaves, watch them spin their silk cocoons and, in a few days, crawl out as pretty white moths, to lay eggs again.

On the tips, edges and undersides

of leaves, and on the stems of any plant where many butterflies or moths are flying about, you can find little chalky dots of eggs, often smaller than pin-heads. Some are alone, but others are laid in strings or clusters. Break off the branch on which they have been laid, for the

*Where to  
Look for the  
Eggs*

### At the "Homely Age"



"Although a caterpillar is long and squirmy it is not a worm. It is a larva or imperfect insect. Its body is nearly always in thirteen ring sections. The head is largest. The next three sections have three pairs of feet. The last nine sections are all stomach. Under the rear end are supports, or false feet. Most caterpillars are smooth, with thin skin lying in wrinkled folds, but many have horns."

leaves will be the proper food for the caterpillar. Put the branch in a jar of water, through a hole in a paper cap, or the squirmy babies may be drowned.

Under a microscope you would find butterfly and moth eggs as prettily colored and marked as bird's eggs, but of many odd shapes. They are globes, cylinders, cheeses, barrels, turbans and pancakes; and some are sharp cornered, ribbed and spiny. Each one has a papery shell, and is filled with a live speck floating in a bath of liquid food, as a chick floats in a hen's egg. That speck grows and soaks up food and wiggles, and finally pushes, or cuts open, a thin door at one end, and

# Some Things the Microscope Tells

Wireless Telegraph Stations with Wings



"A butterfly's antennae are slender, and have a knob or club on the end. The antennae of the moths are tapering, spurred, hooked, hairy or beautifully feathered, but never knobbed. These antennae are fingers, noses and maybe, ears." Yes, and maybe they are part of a wireless telegraph system; for so some scientists think. In the center is a beautiful example of a moth's fringed antennae. On each side is a typical, club-shaped butterfly "feeler."



"The mouth is just two little sucking tubes. If you put a drop of syrup on a leaf you can see the little creature suck it up as a rubber syringe sucks up water. \* \* \* Some of the butterflies and moths need no food and their sucking tubes are closed." When not in use the tubes are rolled up, scroll-fashion, as in the picture.

At the right is a moth's leg under the microscope. The upper part is fringed with long, silky hairs, like a collic's haunches, and the lower, tapering part is covered with clumps of woolly scales.





## The Beautiful Two-Tailed Pasha



Here are four stages in the life history of the butterfly called the two-tailed pasha. The caterpillar in the upper lefthand picture is colored the same rich green as the arbutus leaves upon which it feeds. You can see how this protects it from its enemies. It rests all day on a leaf, as you see it here, and becomes active only at night. Next you see it hanging to a stem by its tail hooks with its head curved upward "like a fat letter J." It is all ready to change to the chrysalis shown at the left below. Finally, you see the full grown butterfly clinging to the chrysalis skin from which it has just come.

crawls out. After that it does nothing but eat and grow and burst out of its skin several times. With plenty of their favorite food to eat, caterpillars will stay contentedly in a glass box, covered with netting, and even spin their cocoons there.

### Why Caterpillars Are Not Worms

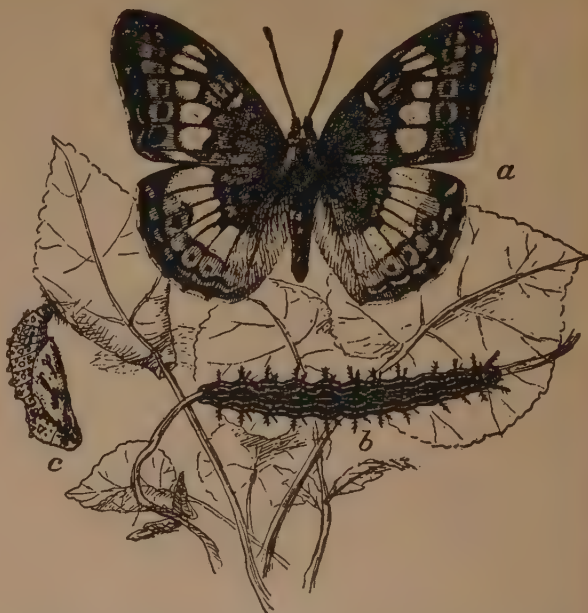
Although a caterpillar is long and squirmy, it is not a worm. It is a larva, or imperfect insect. Its body is nearly always in

*Queer Things About the Caterpillar* thirteen ring sections. The head is the largest. It has a chewing mouth on the under side, with holes for silk-spinning near it. There are tiny knobs that look like blind eyes, and sometimes "feelers." The next three sections have three pairs of feet. The last nine sections are all stomach, with a blood vessel and holes for breathing. Under this rear end are supports, or false feet.

Caterpillars are of all sizes, from tiny black "army" and "measuring worms" and fur moth creepers, to the big green fellows that you see on tobacco plants and grape vines. Most of them are smooth, with thin skin lying in wrinkled folds, but many have horns, spines and tufts of bristles, and some are so covered with silky hairs that they look like fairy muffs. They are usually gray, brown or leaf green, or, if bright, have the same colors as the plant on which they feed. Most of them live

alone. Some are hermits, sewing themselves up in leaves, or boring into fruits and pithy stems. The hidden ones are white. But others

### This Butterfly Lives on Garden Flowers



What do the long, slender antennae with knobbed ends tell you about whether this is a butterfly or moth? And the slender body, shorter than the wings?

It is a beautiful brown and black butterfly that feeds on garden flowers. It likes the passion flower best of all. The caterpillar (b) is yellowish-red with zigzag brown and white lines. It has short, black spines all over its body and two very long ones in front. The pupa (c) is white with brown and black spots and golden, bud-like projections in rows on its back. The picture shows the three stages of the butterfly on some pansy leaves.

live in colonies, weaving web tents over big branches of trees.

Sometimes you can tell whether a caterpillar will turn into a butterfly or moth by the way it makes its cocoon. If a butterfly, the caterpillar will go up a twig, or tree trunk, a wall or rough stone, spit out a button of silk to suspend itself by, curl its tail over its stomach like a fat letter J, and then make itself a banded, horny case. Some butterflies fasten themselves by the tail end and also have a silk girdle strap from the

### How to Tell Butterfly from Moth Cocoons

## The Pasha's Wings

shoulders. Many butterfly pupa cases have gold and silver spots, so they are called chrysalides.

Moths weave silk cocoons, or make plain black or brown oval pupa cases more like the beetles. To do this they often bore into the earth. So, if your caterpillars refuse to climb, give them a box of earth to burrow into. No butterfly spins such a silken cocoon as does the larva of the silk moth, nor does it weave a nest for itself of wool or fur fibers, as do the larvae of the carpet and fur moths.

You can find chrysalides, cocoons and horny pupa cases,

wherever there are trees, shrubs, vines, weeds and old fences and house walls. Any school can make a fine collection in the spring. The last brood of insects of every year sleep over winter like bears. The silk moth, and some others, live over in the unhatched egg, but most butterflies and moths live in their pupa state, sealed up in water-tight, horny shells or gummy silk cocoons.

When in the pupa state a miracle



The upper picture shows the upper side of the pasha's wings. They are brown, bordered with orange and spotted with orange and blue. Below is the under surface of the same wings—gray, maroon, brown, white, orange and black—in a complicated pattern of stripes and bands. The pasha really has four tails, two on each wing, you see, instead of the two which its name implies. It flies high and likes spoiled food best.

takes place. The great stomach shrinks. The biting mouth changes to sucking tubes. The knobby legs stretch and get joints and claws. Webby wings sprout on the sides. The eyes are faceted like diamonds. Put your glass box of chrysalides and cocoons in the sun. Some bright morning you will see one of those prize packages crack open and an insect creep out, feeble and crumpled, the wings moist and baggy. You can watch it unfold and open like a flower.

You can photograph, draw and color the butterflies and moths while

they are getting ready to fly, but do not touch them, or you will rub away the beautiful, dust-like scales that cover the wings. If you find a dead butterfly, sometime, you could

remove the scales and study the wonderful framework of the delicate wings. Every little tube is double. The inner tube is hollow, and filled with air, like the bones of a bird. Outside of this is another tube filled with blood. A thin

*Under the  
Bedclothes  
All Winter*

*Anatomy  
of the  
Butterfly*



## Moth and Butterfly Mimics

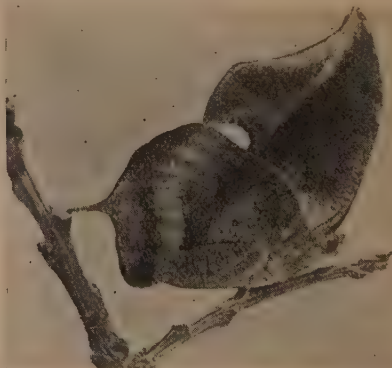


These four members of the butterfly and moth family protect themselves from their enemies by looking almost exactly like their surroundings. In the left hand picture at the top are two orange-tip butterflies on some hemlock blossoms. The butterflies are yellowish-green and white, like the hemlock. But, you say, if they have orange-tipped wings they can easily be seen by enemies. But when the butterfly is at rest it folds its upper wings, those having the orange tips, down inside the lower ones.

The goat-moth on the tree trunk at the right gets its name from its odor which is like that of its namesake. The moth lives and feeds on tree trunks, so its mixed brown and gray coloring is the same as that of its home.

Below, at the left, is the Apollo butterfly, a beautiful resident of the Swiss mountains. It is grayish white with black and red-rimmed circles. With the upper wings folded inside the lower ones as in the picture, you can hardly tell this butterfly from the flowers that it feeds upon.

The South American leaf butterfly, shown at the right below, is tinted a dull brown, the color of dead leaves. Its wings are leaf-shaped, veined, and slightly curled at the edges, like a dry leaf. The gap in the front wing makes it look like a leaf with a piece bitten out. There is a little notch at the base of the wings so that the butterfly can draw its head in, out of sight.



# The Beauties of a Butterfly's Wings

## The Scales on the Wings



"Do not touch them (butterflies) or you will rub away the beautiful, dust-like scales that cover the wings." Here you can see how the scales look under the microscope. Some are really colored, others are tiny prisms, breaking up and reflecting the light so that the butterfly's wing seems to have all the beautiful rainbow hues.

net is stretched over the frame, on both sides; and that is shingled with feathery scales that overlap like fish scales. These are colored, and arranged in borders, spots, and various beautiful markings, as if painted, or enameled.

The body of the butterfly, or moth, is in three parts, as your body is—the head, thorax or chest, and the abdomen. The head is a flattened globe, broader than it is long. The bright, compound eyes are on the sides, and between them the "feel-

*The* *Butterfly's* *Pump Mouth* *ers*" that are fingers, noses, and, maybe, ears. The mouth is just two little sucking tubes. If you put a drop of syrup on a leaf you can see the little creature suck it up, as a rubber bulb syringe sucks up water. Indeed it is just like that. The liquid food is pumped up into a hollow place in the head. From there it is emptied back into the stomach.

## Some Strange and Beautiful Wing Markings

In tropical countries butterflies' wings are very frequently marked with conspicuous and highly colored spots. There are two reasons for this. One is that the bright spots draw the attention of the butterfly's enemies to its wings instead of to its head or abdomen. Butterflies are sometimes found with wings punctured near these spots, which does not greatly injure them. The gaudy markings on the wings really protect the vital parts of the butterfly's body, you see. Another reason may be that the curious spots frighten away some of the more timid enemies of the butterfly.



Notice this curious moth with glazed port-holes in her wings. The wing material is absolutely transparent in these places—you can read print through it.



A species of South American butterflies has a plainly marked figure 80 on the under side of each hind wing. This picture shows you one.

The brain is mostly a pair of optic, or eye nerves. No wonder a butterfly is hard to catch!

All six of the legs grow from the three-ringed thorax, as they did in the caterpillar, and the wings are fastened to this small middle part, too. The abdomen is the largest part. It needs to be large, in the female insect, to make room for many eggs.

Watch the insect lift itself on its jointed legs. It will cling to a twig

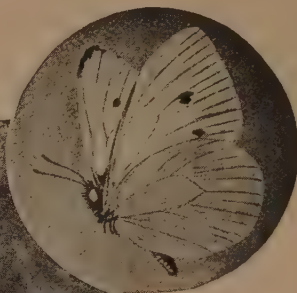


with its tiny, claw-like feet. You may think some of them have only four legs. Two are useless, and are folded on the breast out of the way. Under the back is a tube heart that pumps blood into the wings. Slowly the wings spread and stretch and stiffen to painted, silken sails. They will not need a fresh supply of blood for their few days in the sun. Some of the butterflies and moths need no food, and their sucking tubes are closed.

In the winged form they all scatter the pollen of the flowers they visit, and do no harm at all. If you hatch out the little white butterfly

that makes the cabbage "worm," or the little gray codling-moths that make the apple "worm," or any harmful kind, do not let it go. But many of the largest and most beautiful butterflies and moths live on weeds, so their greedy babies are welcome to their food. For that kind, open the window and let them fly—wild little voiceless poets, weaving their rhymes of color and motion on the air.

*Little Poets  
of Color  
and Motion*



**The Little  
White Butterfly  
that Has So  
Many Children**

If all the eggs of just one little common white butterfly hatched and grew to maturity, in three years we should have one billion butterflies flying over the land in its place. If these should visit New York, for instance, they would cloud the sky and make night out of day with their numbers.



# IN THE GREAT WORLD OF NATURE

## ANTS

### Clever People in Buried Cities

IN THIS big world of ours there are strange cities that have thousands of inhabitants. The grown people in them are as busy as can be. Some are always building, repairing, and keeping the city clean. Some go outside to gather supplies, or act as soldiers to guard the city from enemies. Others take beautiful care of the children. They wash, dress and



"Good Morning"

Miss Ant is standing in the door of her apartment in the early morning sunshine, washing her face. She knows as well as you do that that is the proper way to begin every day, and what's more, she never has to be told to do it!

*Good Aunts Among the Ants* are queen mothers in those cities, who are attended by maids of honor, but they do not give orders. Everyone understands his duty and does it without being told. It is thought that every citizen knows how to do all kinds of necessary work, and rests by changing work with others. Each one toils cheerfully, not for himself alone, but for the common

good. So, in those cities, everyone has what he needs, and no one is either rich or poor. Everyone is peaceable, and there is no quarreling or disorder.

Now, if some traveler were to come home, from a far-away country that no one had ever visited before, with such a tale as that to tell, wouldn't you be interested? You might even plan to go to see those cit-

ies when you were grown up. You would think that a great deal could be learned from people so industrious, unselfish, wise and good-tempered.

#### Did You Ever Visit an Ant City?

But you won't have to wait to grow up, nor take a long journey to visit one of these wonderful cities. You can find such a city on any grassy or sandy bank, around the roots of trees and stumps, and even above cracks between the bricks and stones of

## The Ant House in the Woods



The wood ant builds a nest of twigs, pine needles and grass. These nests are sometimes two or three feet high and are connected by roads or tracks with other nests near by. The ants from all the connecting nests are on friendly terms with each other, but if a stranger ant comes in, he is killed instantly.

sidewalks. The cities are just ant hills, and they are the most interesting things in the world for big and little people to study.

All you could see, at first, would be a little round mound of sand,

*This is the Roof of the Town* loosely piled and punctured with many

tiny holes. Through the holes, clean, wingless insects a quarter of an inch long, or less, hurry in and out. From the number of busy little bodies it is plain that the dome is only the roof of an underground town.

### The Honey-Maker



Here is one of the honey ants that live underground and have a special class of workers, called "honey-bearers." They are fed by the workers and produce honey in their enormous abdomens. The honey is eaten by the rest of the colony.

If they were carpenter ants, that cut many storied homes in decaying trees, stumps and logs; ag-ri-cul-tur-al ants that grow, harvest and store grass seed in underground gran-ar-ies; or honey ants,

*Isn't this a Strange Thing?* that store up grape sugar in their own

bodies, I could tell you all about them. Or, I could tell you about the ants of the heart of Africa, for example, because wise and patient men have spent years in studying them. But we know least of all about the common house



## A "Big Palaver" in Africa



The ants of Gold Coast Colony, in western Africa, sometimes hold a general assembly in this fashion. The negro natives call it a "big palaver." The ants are symmetrically arranged in circles around the small open space in the center. They all face outward, nippers held up, apparently guarding the central open space where a few larger and lighter-colored ants, evidently important members of the colony, are gathered.



## Inside the Ants' Apartment



Here is a cross-section of an ant-hill. At the bottom are the cavities or rooms where the tiny, legless white grubs are sheltered. At the left an ant is taking the "little white oblongs that look like grains of barley" up above ground. "Those are ant babies out for an airing. They are not perfect insects, but grubs, wrapped up in pretty silk cocoons, as pretty and soft as the silk moth's cocoon, but, oh, so tiny!"

and pavement ants of America. So here is a chance for some American boy or girl to win fame as a naturalist.

### What Are the Ants Doing with Those Pellets?

To begin with, so far as we can see, our pavement ants behave much as do other burrowing ants. So we can make a pretty good guess as to what is going on in the dark, underground home. If you will watch ants that are going into a nest, and you should have a good big magnifying, reading glass that you can move about, you will see that they are always carrying things. They carry bits of straw and bark and pellets of clay, no doubt for waterproofing their homes, and they carry

all sorts of things home to eat.

Bees eat only honey and pollen, but ants eat soft seeds, butterfly eggs, bits of fruit pulp and sugar, and crumbs left by people who have eaten picnic lunches on the grass.

Ants eat animal food, too. Sometimes you can see them dragging dead flies or caterpillars several times as large as themselves. When one finds that it has a bigger load than it can manage, it lays it down, and hurries home. If it meets other

ants coming from the nest, it stops and touches them with its feelers.

Very likely it tells what the trouble is, for soon it comes back with helpers. Several ants take hold and push and drag the trophy to the hill.

*How to  
Discover  
Ant Secrets*

*The Ants'  
Bill of  
Fare*

*How the  
Ant Calls  
for Help*

There it is cut into bits that can be taken through the tiny tunnels into the nest.

You notice some ants coming out of the nest are not carrying anything. They hurry away on various

to make rooms and galleries, and other waste. They are as clean little housekeepers as bees. Such things they take some distance from the nest and drop. But when they bring up little white oblongs that



## Three Guests in the Ant Household

Although ants will often attack a strange ant coming among them, they are hospitable to other kinds of insects. They allow them to live in their nests and eat from the common supply of food. The insect shown on the left is the springtail, a guest in the ant household. In the middle is one of the aphides—a white wood louse which supplies the ants with a syrupy liquid when “milked.” The third picture shows a beetle which is often found in the ants’ home. Possibly the ants reason this way:

“By welcoming the aphides, which are no kin to us, look what a fine lot of cows we got. Who knows what other strangers may bring us?”

Who knows, indeed! Such wise little heads, these ant heads. No wonder the wisest of men learned wisdom from the ants. (See Proverbs 6:6.)

errands, along certain paths, or main traveled roads. It is thought that they follow each other along these paths by the sense of smell. If you put an ant off one of these paths, some distance from home, it is puzzled and runs around at random. If you even draw your finger across a path the ants seem to lose the scent, as hunting dogs do at running water. Ants have been seen to run up and down a finger mark, go around the end of it and pick up the scent on the other side. But if you put a pebble on the path they are apt to climb over it, instead of going around it.

*Why Ants  
are  
Like Dogs*

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## How Neat Our Little Ant Is!

Some ants, in coming from a nest, bring up earth that has been dug out

look like grains of barley, they lay their burdens carefully on the hill top and stand guard over them.

Those are ant babies out for an airing. They are not perfect insects, but grubs, wrapped up in pretty silk cocoons, as pretty and soft as the silk moth’s cocoon, but, oh, so tiny! The sun warms these babies, and helps them get ready to break out of their cradles. If a cloud appears, chilling the air, the nurse ants hurry the babies indoors.

Then is the time that you would like to lift the roof to see what is going on. If the homes of our pavement ants are like those

*“A House  
of Many  
Mansions”*

of other burrowing members of the family, there is a shaft or up and down tunnel, several inches deep. At different

## The Weaver Ants of India



In India there are ants that spin. Below are pictures of the worker and female of this spinning ant family. The females are bright green and winged, but the workers are reddish-brown. The upper picture shows how these ants weave leaves together to make homes for themselves and cow-sheds for their cattle. The grown-up ants cannot spin, but in the grub stage they spin cocoons for themselves. When the children have reached that stage in their growth, they are put to work by their industrious elders at weaving together the leaves of the tree which is their home. In the illustration you see the ants with grubs in their jaws, carrying them back and forth over two leaves which are held



levels galleries run out, making a many storied house. Big and little rooms open from the galleries, the ceilings held up by earth pillars, exactly as in a mine. Connecting doors are

close together by other ants. The thread-like substance which the ants squeeze from the mouths of the grubs is woven into a fabric by carrying them back and forth across the opening. The material formed in this way is strong enough to be written upon like paper. Some of the nests are a foot across. Others are tents or cattle sheds for the louse and caterpillar cows kept by the ant colony. At the bottom of the picture a number of ants are making a meal on a big beetle, though he is many times their size. On a leaf at the top you see a female caring for her first batch of grubs. She takes care of this brood all alone, but they grow up to help her before the second brood comes.

just round or oval holes, and may be made anywhere, for ants can climb up or down, forward or backward or upside down.

#### How the Ants Keep House

There are three kinds of insects in



## Ants that Raise Their Own Crops



In the tropical forests of South America you sometimes meet a procession of ants like this one. They look as though they were carrying leaf umbrellas to protect them from the hot glare of the sun, but they are getting their fields ready for crops. They are the sauba or leaf-cutting ants, who fill underground rooms of their nests with bits of leaves. The leaves decay and grow a kind of mushrooms which the ants eat. The smaller picture shows the leaf-cutting ant and an imitator, the membracid. This insect, near the righthand corner of the picture, is a defenseless, plant-sucking creature that wears a green hood. You can see how much he looks like the ant with the leaf on its back. For this reason he is mistaken for one of their own workers by the ants and so goes about among them unharmed.

an ant's nest, as in a bee hive. There are queens, workers, and sometimes drones. The queens lay all the eggs, as queen bees do, but they are not jealous, and do not try to kill each other. Several queens may live

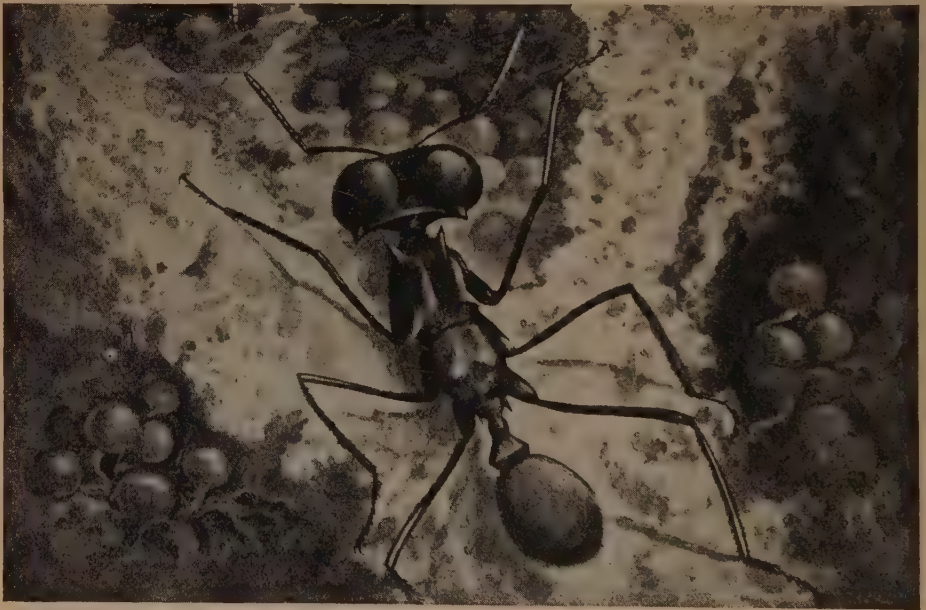
*So Careless With Her Eggs* peacefully together in one nest. They are fed and petted by the workers. And each ant queen has maids of honor to follow her about, because she is so careless about her eggs.

A queen bee lays each egg by itself in a wax cell, but an ant queen mis-lays her eggs. She strolls about a good deal in the galleries, and drops her eggs as she goes. Those

They pick them up, lick them all over and carry them away to dry, warm nurseries.

Most of the work inside an ant hill seems to be connected with babies. A very simple burrow would do very well for grown ants, but not for the babies. There are certain rooms where the eggs are heaped up; it is thought this is to keep them warm. The eggs are watched, carried up to sun-warmed rooms in dry weather, and down into waterproof basement rooms when the weather is cold or rainy. It takes the eggs two weeks to hatch. For days and days the legless grubs have to be fed

#### Mushroom Crops of the Sauba Ant



Here is a section of the leaf-cutting ants' garden, ready for the harvest. The fungus grows into little knobs, you see, which would develop into big mushrooms if left alone. But they are bitten off and used for food by the colony.

eggs are so small that you could not see them. But, in the pitch black passages underground, the queen's attendants find every one.

*Putting the Eggs to Bed*

from the mouths of nurses, and kept clean by licking and scraping. Babies of different ages are kept in different rooms. When they have

*Graded School in Antdom*



spun their cocoons and gone to sleep, "babies and cradles and all" are taken out in the sun, every sunny day for a month.

## Helping the Babies into the World

The baby insects cannot get out of the cocoons by themselves, but must

and drones that must leave the nest to start new colonies. They are hatched out in late summer. They boil out like bees and fly straight upward. The drones all die, and many of the queens. Those that come to earth again cannot go back

## How the Ants Take Their Cows to Pasture



Many aphides live on roots underground. These "cows" are liked so well by the ants that they gather their eggs and guard them in the nest during the winter. Here you see the ants carrying some of the young aphides to the roots which are their food. The young aphides were hatched from eggs in the ants' nests. Some aphides salute their ant hosts when they meet them with a lift or kick of their hind legs. A species of yellow ants lives altogether on sweet milk furnished by their aphid cows.

be helped out. The nurse ants open the silk case, draw the infant out, straighten its legs and stand it up, feed it from their mouths, and, if it has any, smooth its crumpled wings. Sometimes they help a baby out too soon, and have to work over it for an hour or more to save its life.

You never saw a winged ant? *Ever See a Winged Ant?* Some day in the early fall you may see a swarm of winged ants leaving an ant hill, if you watch one. The winged ones are young queens

to their old nest. Some of them are captured by ants in need of another queen. If not they are obliged to start new colonies by themselves.

## How the Ant Queen Takes Off Her Wings

The queen will never need her wings again, and, indeed, they seem to be very in-se-cure'-ly put on. Her captors pull them off, or she very sensibly rubs the useless things off against rough bark or stone. A queen starting a colony has a lonesome time for quite two months, and lonesomeness must be hard for a



## The Caterpillars, the Cows and the Ants



The green flies are aphides that live on rose bushes and other garden plants. They are kept for their honey by ants, but the big Chinese butterflies are near them in the picture for another reason. The butterflies lay their eggs among the green flies that swarm up the stem of a plant. The caterpillars that hatch from these eggs live entirely on the green flies. The ants here are busy herding their aphid cattle, but they don't seem to realize that the caterpillars are destroying them, for they make no effort to protect the aphides.

sociable ant to endure. She has to dig a nest, and bring up the first small brood herself. But after that the queen mother has a life of ease and honor. She never leaves the nest again, and is not driven out, when old, as a queen bee is. She lives longer, too, sometimes six or seven years. Worker ants, too, live over several winters. Worker bees live only six weeks or so, a few of the last brood living over winter.

*Ants Are  
Kinder  
Than Bees*

#### But Ants Aren't So Thrifty as Bees

That is odd, for ants do not store food as bees do, for winter use. Most of them live from hand to mouth, gathering every day only what is

needed at the time. They cannot make wax or honey. The honey ants have one kind of worker whose body is used as a bottle by the others to put grape sugar in. The farmer ants store grass or grain seed, but neither puts in a winter's supply. The many things that ants eat decay quickly, as a rule, and could not be stored. In the winter ants seem to sleep as bears do, and to be able to go a long time without eating. On very warm, sunny days in winter they often come out to stretch their legs, and to get a meal.

*Farming  
Among  
the Ants*

#### Milking the Honey Cows

There is one thing that nearly all

#### Ants as Engineers



These ants were used to taking this track in their daily travels. On rainy days it was sometimes overflowed by a stream of water, so what did these clever little people do but tunnel under the part where the water flowed. A similar tunnel made by African ants was thirty-two feet in length. It had air or escape shafts a foot or more below the surface and near the places where a wash might occur.

ants do, if they have a chance. They milk cows for honey. You can find their cows on the stems and leaves of rose bushes and other tender plants with sweet sap. They are little, soft, green bugs, called aphides, or plant lice. Mrs. Lady Bird is very

*Can You Find the Cow*

from two tubes above the tail end of the aphid. The ant licks these off greedily and then milks another aphid. There is a root-sucking aphid that certain ants keep in their nests and milk regularly. Indeed, there are all sorts of guests in an ant's nest

*Keeping Cows In the House*

### The Ant's Ungrateful Guest



The picture on the right shows an ant getting a sweet, syrupy meal from the two tiny openings on the back of a beetle. On the left the beetle is telling the ant that it is hungry by tapping the ant's head with its feelers. The ant will give the beetle some food from its own crop. This particular species of beetle is found in Europe and northern Asia. The beetle grubs are like those of the ant, but much greedier. The ants care for them along with their own offspring, but the ungrateful beetles devour great numbers of ant grubs. After the beetles have been in the nest for several years the number of worker ants is reduced to such an extent by this killing off of their grubs that the ants try to turn some of their female grubs into workers by feeding them on worker food. Ants can and do create females by feeding them special food, but having once started to make females, they cannot change them back to workers. They only succeed in producing ants which are neither true females nor perfect workers. At first the number of beetles is kept down because the ants unintentionally kill them. They carry about the beetle chrysalids as they do their own cocoons, which kills the sensitive young beetles within. But as more false females and fewer workers are produced by the ants, fewer beetle chrysalids are disturbed, and the ant colony is finally destroyed by the beetles.

fond of them. Numbers of them sit still, sucking the juices, and turning them into honey in their bodies. If you watch a group of the aphides a little while you will be sure to see a business like ant traveling up the branch.

Selecting a fat aphid the ant pats it gently with its "feelers" on either side, as much as to say: "So, bossy cow, so, so."

Two little beads of honey ooze

—aphides, grasshoppers, beetles and slave ants, captured in war. The slave ants are always black, the captors, red or brown. Soldiers, or workers with stingers and fighting jaws, attack another nest, kill the defenders and carry away the eggs and cocoons. These they care for, and, when hatched, make slaves. But the slaves seem contented, work as industriously as their masters and do not try to get away.



## Lives that Teach Great Lessons

To the Readers of Pictured Knowledge:

### THE WORLD'S HELPERS.

In the history of every nation there are a few great names that, "like peaks of sunken continents rise from oblivion's sea." The thoughts and acts of these men and women determine the course of history. They give color to their nation's record. They are the builders of its reputation. It is these we have in mind when we consider a nation's virtues. When we think of the Greek as a lover of philosophy, harmony, and beauty, we do not mean that every Greek partook of the genius of Euripides or Phidias or Plato, but that there were such among the Greeks, fine strains of human heredity more precious than any other possession of the nation. The slaves, the foreigners, the men on the street were not touched with "the Glory that was Greece." Nor did this glory endure, when suicidal wars had put an end to the whole race of Hellenes that originally sprang from Mycenae. Similarly the Egyptians named the stars, built the pyramids and did many wonderful things. But this was the work of the chosen few. The average pariah of the Nile never named a star, nor accomplished any other feat termed Egyptian. The Romans were the world's law-givers, but not many of them had any concern in Equity. And if freedom was born in England, there have been many thousands subservient and complaisant Englishmen for every Pym, Hampden, Cromwell, Cobden, Bright or Bryce.

These fine strains occur in every human stock. They give our races their character. They give our institutions stability. They are the "men who command while the world obeys." They are the men and women who can see what commands are possible and what are the needs of the world. He who strikes as the gods strike has the force of infinity in his blows. He who defies them wields a club of air.

And this aristocracy of mind and morals are not the world's nominal rulers. To rule by force is the cheapest, crudest and most unworthy form of domination. The truly great of the earth are the World's "Helpers." It is the noblest attribute of democracy that it gives these their opportunity. Democracy asks, not for rulers but for helpers, and it asks of these no credentials of aristocratic birth or breeding, but only this, - Can they help?

And a democracy can find place for all the varied kinds of genius, not alone for the soldier, the prophet and the priest. More and more the services of science are coming to the front in human appreciation. Science is human experience, tested and set in order, and the lessons of human experience can be applied at every turn to the betterment of human conduct. In every field of knowledge, of art and of ethics can be found World's Helpers and each one of these is entitled to the only reward they have asked, the grateful memory of those that follow them, and of those that they have tried to help.

David Starr Jordan

## The Neighbor Lady of Hull House



"Those who knew her best called her 'Saint Jane.'"

"WHEN I grow up, I am going to have a big house, not with green grass and trees about it, like ours, but right in among the horrid, crowded little homes of poor people, and be neighbors with them."

### Father and Daughter

This is what a seven-year-old child once said to her father. She was a pale, quiet little girl. Her

back was crooked from curvature of the spine. She loved her tall, handsome father, who *A Friend of Lincoln* was so tender of his crippled daughter. She was proud because he had been a friend of Mr. Lincoln's. He had letters from the great president beginning: "My dear, double D Addams."

Jane Addams never forgot about the "horrid little houses"



that she saw in the poor quarters of the pretty city of Cedarville, Illinois, where she was born in 1860. You see, she could not play like strong children, so she read and thought a great deal, and talked with her big-hearted father. One day she found him looking sorry over something in a newspaper.

#### Her First Knowledge of a World Friend

"Joseph Mazzini, the Italian patriot, is dead," he explained. Twelve-year-old Jane did not understand.

"Why should *you* feel bad? *You* didn't know him."

"No. But all lovers of liberty mourn his death. He was a brother to all mankind, helping not Italians alone, but many peoples he

*Why the World Mourns Men* had never seen, to win freedom." That was another thing Jane never

forgot. It helped her to think out how she could help the thousands of emigrants who come to make new homes with us, to be Americans. So poor, so puzzled, so friendless in a strange land, we let them come, but do nothing for them. They drop into the big "melting pot of the nations," as our country has been called, and we expect them to become Americans without help. To get her big house among their "horrid little ones" and be neighbors, would be, she thought, a kind and useful thing to do.

But first she had to go to college and travel abroad. She was twenty-nine, a strong woman with a nearly straight back, when she and her school friend, Miss Ellen Starr, went to live in Hull House, a fine old mansion in the most crowded foreign district of Chicago. She built a

bright fire in the hall of her lovely American home, and invited her prosperous Irish and German neighbor women in for a cup of tea. She got them to help her give a party to the Italians. And when they saw what beautiful manners the Italians had, how they could sing and dance and talk of the art photographs on the walls, they stopped calling them "dagoes." That was the beginning of neighborliness. The Greeks were invited, the Russian Jews, the Bohemians, and the other nineteen tongues of the Chicago's nineteenth ward.

Soon there was a reading room at Hull House and evening classes in English; an art gallery and studio; men's, boys', girls' and mothers' *What They Do at Hull House* clubs; a gymnasium and shower bath; a day nursery, kindergarten, and pure milk depot; a coffee room and restaurant; a dancing and lecture hall, and a stage for giving little plays. Other buildings were put up, among them a model tenement. Hull House sheltered a colony of earnest people, and the rich offered both money and services.

First, Miss Addams fought loneliness—she made Hull House a center of social life. Then she fought dirt, ignorance, sickness, bad working *Neighborliness and Good Citizenship* conditions, and bad housing. She got herself appointed garbage inspector. At five o'clock in the morning she was up watching the wagons. There was a clean-up day, the children collecting paper and tin cans, the women sweeping alleys and streets and clearing the fire escapes. Then she got a Juvenile court; and new child labor, factory, and tenement house laws. With forty people sometimes working and living

with her, Miss Addams stood in the center of things. Such beautiful manners she had — always the same for the "Colonel's lady and Judy O'Grady," the poor scrub woman, the push cart man, or the troublesome child. In ten years she was called "the first citizen of Chicago." She served on the school board, was elected president

of the National Board of Charities, and was honored with degrees by several universities. Those who knew her best lovingly called her

*The Irish  
Woman's  
Tribute*

"Saint Jane." An Irish woman neighbor of hers has said:

"If there be anny that will have respect in their buryins it's our Saint Jane."

## Who Is My Neighbor?

*Thy Neighbor? It is he whom thou  
Hast power to aid and bless;  
Whose aching heart or burning brow  
Thy soothing hand may press.*

*Thy neighbor? 'Tis the fainting poor,  
Whose eye with want is dim,  
Whom hunger sends from door to door;  
Go thou and succor him.*

*Thy neighbor? 'Tis that weary man,  
Whose years are at the brim,  
Bent low with sickness, care and pain;  
Go thou and comfort him.*

*Thy neighbor? 'Tis the heart bereft  
Of every earthly gem,  
Widow and orphans helpless left;  
Go thou and shelter them.*

*Where'er thou meet'st a human form  
Less favored than thine own,  
Remember, 'tis thy neighbor worm,  
Thy brother, or thy son.*

*Oh! pass not, pass not heedless by;  
Perhaps thou canst redeem  
The breaking heart from misery—  
Go share thy lot with him.*

ANONYMOUS

## The Man Who Won a Great Victory



This is the soldier—Col. George Washington Goethals—who, in the building of the Panama Canal, achieved one of the greatest “military victories” and the greatest engineering triumph in history.

“Broad shouldered and erect, as he had learned to carry himself at West Point, everyone knew him. He was a Czar of Russia for power, a King Solomon for wisdom, an Edison for work.”



## SOME OF THE WORLD'S HELPERS

### Col. George Washington Goethals

"The Boss of the Job"



These little pictures show both sides of the medal given by the Geographic Society of Chicago to Col. Goethals at a banquet tendered to him on the date shown. The figure of the Phoenix rises from the flames, on her breast the motto, "I Will." Her own history is a striking example of what can be accomplished by energy and determination, it is very fitting that she should recognize in this way the work of the great engineer who joined the oceans. On the obverse side of the medal (shown on the right) is the shield of the city, and on either side the land masses of the two hemispheres. The heads of wheat and the ears of corn stand for the products of the great Mississippi Valley, so greatly benefited by the new water route. On the other side are the laurels Col. Goethals has won.

THAT is the "See Colonel Goethals, tell Indian coolies.  
chorus of a Colonel Goethals, Sailors of all  
popular song *It's the only right and proper* nations, traders  
sung in the Ca- *thing to do.* and tourists were  
nal Zone while *Just write a letter, or even better* coming and go-  
the Big Ditch *Arrange a little Sunday inter-* ing. There were  
was being dug. *view."* two seaport ci-

To understand the fun and sober truth in that song you would have had to live under the strict but kindly rule of the Chief of the Panama Canal Commission.

At first our Congress provided only for the work being done, but nothing much could be done until order, safety, health and contentment of workers were provided for. There were thousands of men and their families of many grades and nationalities—American engineers, chemists, electricians, machinists, teachers, nurses; Spanish Americans and Indians; Jamaican negroes; East

ties, many native villages, work camps, schools, hospitals, government stores, a railroad and millions of dollars' worth of machinery and construction material. And there was no government, as we understood it, no citizens, no elections, no courts. A good "boss" was what was needed. It was President Roosevelt who decided to put the work into the hands of Army Officers. They were used to giving and obeying orders. A board of seven commissioners was appointed with Colonel Goethals as commander in chief. This Canal Zone became a military camp.

*The Little  
World at  
the Isthmus*

**"Czar" Goethals and His Empire**

Colonel Goethals was a Czar of Russia for power; a King Solomon for wisdom; and an Edison for work. He was up at six o'clock, and off for a four-hour tramp along the line, watching everything. Broad shouldered and erect, as he had learned to carry himself at West Point, everyone knew him. "His alert face was that of a boy of twenty; but his eyes were forty, and his hair sixty." In the afternoon he was at his desk in the big, barn-like administration building, above

*Goodness!*

*How that*

*Man Worked*

thinking. He never seemed to see the dark blue velvet sky of the tropics, with its sparkling stars and golden moon. He did not see the palms or flowers, or seem to hear the music and laughter from gay companies on the lawns. In fifteen minutes he was sound asleep.

But Sundays? He could rest then, couldn't he?

**The Colonel and His "Trouble Court"**

No. On Sundays he held court. Everybody with a grievance wanted to "tell the Colonel" as the song says. He was the Judge of their

**Home of Colonel Goethals in Panama**



This is Colonel Goethals' home in Panama. It is on a hill, overlooking the big Culebra Cut which caused Uncle Sam so much trouble. It is no bigger than many other houses at the "Big Ditch." The screened-in porches running clear around both floors and the tropical palms in the yard tell you of the hot climate. It was on this porch that the Colonel held his "trouble court" every Sunday.

the Culebra Cut. That office ran like a machine. Every map, plan, and record was properly filed. He had a courteous word for every visitor. No one realized that these many interruptions obliged the "boss" to work after nightfall. His light went out at ten, long after everyone was gone. He walked home, head down,

*He Showed  
Courtesy  
to Everyone*

court of justice, a sort of Haroun al Raschid the Just, of the Arabian Nights.

Such foolish complaints and squabbles as he had to listen to—

*There Were  
Such Foolish  
Complaints*

quarrels between neighbor women and laborers. People did not like the houses they lived in; or the butter at the government store. A Jamaica

negro demanded the money his wife had earned over the wash tub. He was a British subject he said, and that was the English law.

"You get American law in the Zone. The money is hers," Colonel Goethals said. He ordered damage claim papers made out for a man hurt at his work. He refused to reinstate a gang boss who bullied his men. The man cried out angrily that he would appeal the case.

"To whom?" said the Colonel, smiling.

"But I'm an American citizen. I have rights."

"The only right you have here is to go home, if you don't like it. There's a steamer three times a week."

Until noon he sat on his veranda, listening, deciding, sending most people away satisfied with having

Col. G. W. Goethals, D. S.



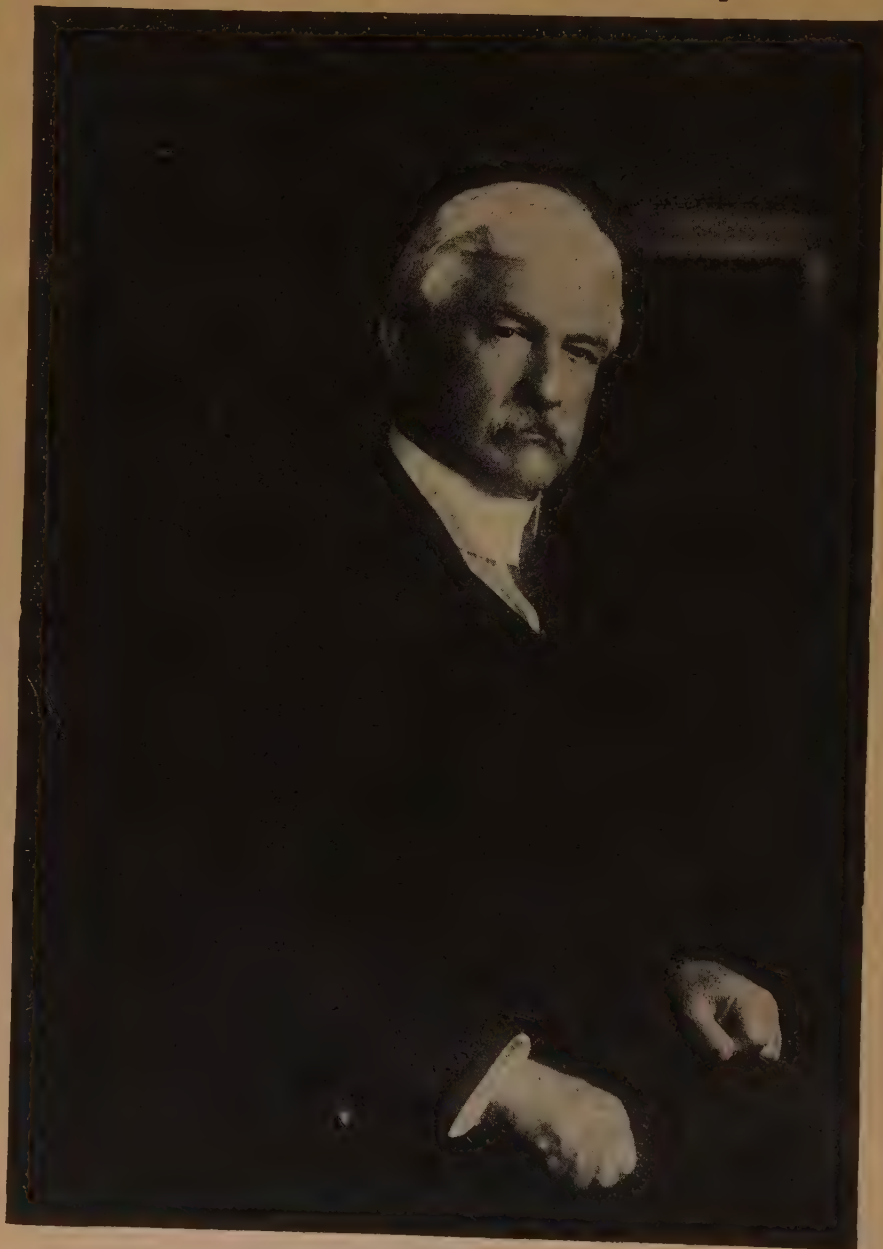
Columbia University gave Colonel Goethals the honorary degree of Doctor of Science, in recognition of his great work in Panama. This is how he looked as he was being congratulated.

"told the Colonel." Week after week and year after year, he stayed "on the job." He never had a vacation. He never talked about himself. Before a committee of Congress he summed up thirty years' army service in one hundred sixty-seven words. Under his rule in Panama there was no disorder, no waste, no stealing from Uncle Sam. He was not popular in the same sense as was Colonel Gorgas, the jolly health commissioner; but every-

one trusted him, and admired him for his clean, honest, effective work.



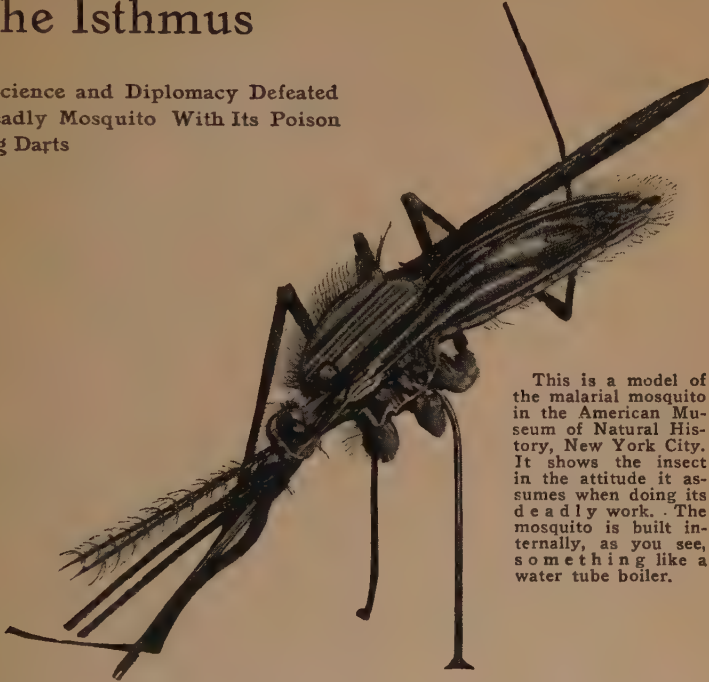
## The Man Who Conquered the Mosquito



"He is a strongly built man, with a kindly smile and twinkling eyes. And how sweet and human he is."

## Colonel Gorgas and the Little Terror of the Isthmus

How Science and Diplomacy Defeated  
the Deadly Mosquito With Its Poison  
Bearing Darts



This is a model of the malarial mosquito in the American Museum of Natural History, New York City. It shows the insect in the attitude it assumes when doing its deadly work. The mosquito is built internally, as you see, something like a water tube boiler.

**“HELLO** Central! Give me the Sanitary Commission. Hello! Is this the Health Office? There's a mean, blood-thirsty mosquito in my house. Send an officer, please.”

### Where Policemen Arrest Mosquitoes

Such nonsense! Is it meant for a joke? No. It is an everyday happening, along the Panama Canal, to call a health officer to arrest a mosquito burglar. There are terrible beasts and snakes in the hot, green jungle, but no wild animal in tropical

America is as dangerous as the mosquito. It may give malarial or yellow fever to anyone it bites,

*Mosquitoes  
Worse Than  
Jungle Beasts*

and then, by biting the sick, spread these diseases to well people.

After a full meal of blood the mosquito hides, high on the wall, in a dark corner or closet or hanging garment, and goes to sleep. If one is in a house health officers find it.

### In the Pest Hole of the Americas

In 1900 Panama was, as it had always been, the worst pest hole of the Americas. For nine

months in the year it rains there every day. Fifty varieties of mosquitoes breed by billions in the swamps and slow, broad streams. Doctors learned that certain diseases are given by these little nuisances. If white men were to live there and dig the canal, the mosquitoes had to go. So the government sent Colonel Gorgas, an army engineer and surgeon, and made him family doctor of the Canal Zone.

#### How They Got Rid of Mrs. Y. F. Mosquito

There are many kinds of people in Panama—Americans, Spanish-Americans, Negroes, Chinese coolies. Natives never have these fevers, and are ignorant about health

rules. They could not understand why the “wiggletails” in open rain-water barrels and out-of-door closets did any harm. They could see no use in cleaning and fumigating their houses. But Colonel Gorgas was so jolly and friendly, they did anything he asked, just to oblige him. They let him put in a water system and sewer and fill up the pools in the villages, although it no doubt seemed a queer thing to do.

#### Then Came Mrs. Malaria Mosquito

That settled Mrs. Yellow Fever Mosquito, but Mrs. Malaria Mosquito laid her eggs everywhere. All along the Canal Zone, swamps had to be drained. Then, back in

#### In the Panama Jungle



“There are terrible beasts and snakes in the hot, green jungle, but no wild animal in tropical America is as dangerous as the mosquito.” Here’s a bit of the jungle with a malaria-breeding puddle. And the natives in the picture, Negroes, are of the kind that “never have these fevers and are ignorant about health rules.” The big palm with the frayed leaves on the right is a banana tree. See how the girl is carrying one of the native “water buckets,” an earthen bowl, of which there are several more on the ground at the left.



the hills, across every rivulet that flowed to the villages, iron ash cans were set on plank bridges. The cans were filled with crude carbolic acid, resin and caustic soda. This oily poison oozed, drop by drop, into all the streams and spread over the water. When the mosquito wiggle-tails came up to breathe they were killed. Negro porters, carrying tanks, sprayed the poison into every pool. Doors and windows were screened with copper wire. A person sick of fever was rushed to a hospital. Health officers vaccinated people. Others trapped, poisoned and shot wharf rats at the seaports, for rat fleas carry the black plague. It has cost millions of dollars to make this hot, damp country as healthy as a northern city. It will cost more millions, every year, to keep it so healthy that ships will not carry diseases elsewhere.

#### The New "Bill of Health" for the Zone

What do you think the health officers call themselves? "Ditch diggers." Colonel Gorgas says that, by keeping the workman in good health, the Sanitary Commission took half the dirt out of the Culebra Cut. Through his good work he keeps families together, mothers and babies on the green, palm-shaded lawns, a swarm of rosy children

tumbling boisterously in and out of white school houses. He says he intends to make the Canal Zone so healthy, that a man will have to break a leg to get into a hospital.

No other work done on the Canal has been more important or difficult; no other has affected so many far-away lands and peoples. In countless places Colonel Gorgas' methods of fighting germ diseases and insect carriers are being copied. And how sweet and human he is. Do you want a picture of him?

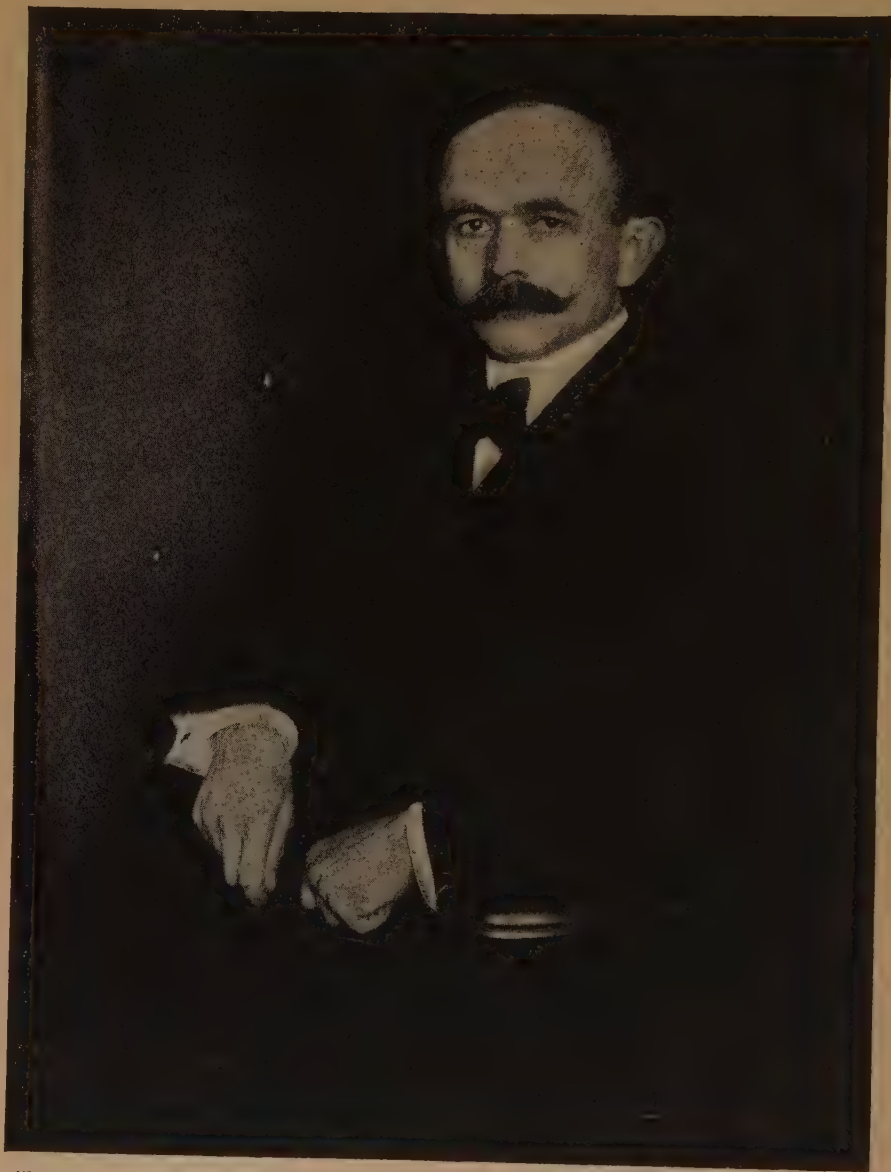
#### A Pen Picture of the Soldier Doctor

He is a strongly built man, with a kindly smile and twinkling eyes. He wears white duck, a soft shirt and Panama hat. In any native house he may be seen, with fat, brown children scrambling over him. He slaps the men and boys on the shoulder. To the lady he says: "Senora (Madam) you certainly do make the best lemonade on the Isthmus. I just turned your rainwater barrel upside down." Then to the husband:

"Senor, if you don't fill up that puddle in your back yard, I shall have to put a fine fellow in jail. How many toes has baby Rosalie got? Five! That's just the right number to play a game I know:

"This little pig goes to market"—

The Man Who Taught the World That  
"No Boy Can Be a Criminal"



"Today, hundreds of honest and useful men bless the 'kid' Judge for giving them a new start, and saving them from the disgrace of having been in a reformatory."

## The "Kid" Judge

**T**HAT doesn't mean a *child* judge, but a judge of children. It is the slang nickname that the boys of Denver gave to Judge Lindsey. It is an affectionate pet name, too, for they love him. He would not trade that name for the proudest title in the world. This is how he got it.

### An Appeal to a Boy's Honor

In 1900, when he was thirty-one years old, he was elected judge of the Probate Court in Denver. There was no Juvenile Court then. When a boy was arrested his case was tried by any one of several judges. One morning a "gang" of boys were brought before Judge Lindsey, charged with robbing a pigeon roost. That was stealing. The law called it a crime, no matter whether the guilty person was six years old or sixty. The boys hadn't thought of it that way. In taking the pigeons they saw, they were just teasing an old man who was ill-tempered and mean to boys. Judge Lindsey explained the law. He must send them to the reformatory at Golden.

Then he remembered something. With a crowd of boys he had once started to raid that same pigeon roost, to "get even" with the cross old farmer. The other boys did do it, but Benny Lindsey backed out because he

*Robbery  
of the  
Pigeon Roost*

was afraid. Those boys had all grown up into good and useful men who would not think of stealing. What if they had been caught and punished as criminals?

"Would I be here now, to judge these boys? No. I would probably have been discouraged and turned bad."

### Then He Said This to the Boys:

"Boys," he said, "do you know what a parole is? Prisoners of war in camp, where they cannot be locked up, give their word of honor not to escape. I will parole you. You must report to me once a week. If you break your word and get into trouble again, I shall have to send you to the reformatory. I will be criticized for giving you this chance to reform yourselves. If I trust you, and I believe in boys, why, you must stand by me."

He was a small, boyish-looking man, with a big head and frail body, and he talked to the boys as though he were one of them. So they called him the "kid" Judge, and stood by him, because he understood "kids." So successful was this new idea of getting boys to behave "on honor" that other judges sent all the children to Judge Lindsey.

*How the Boys  
Stood By  
the Judge*

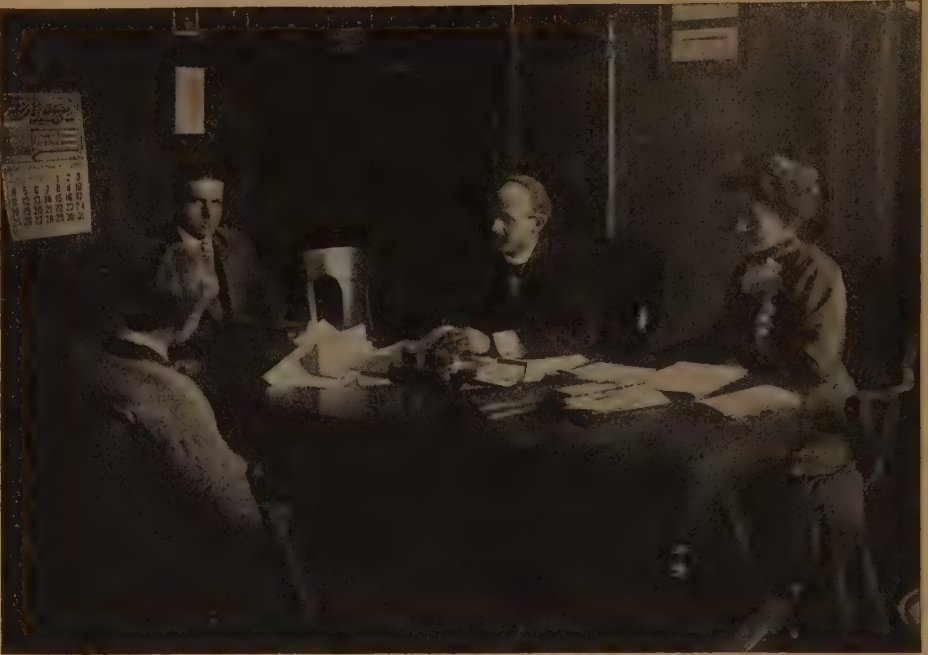
### A Live Boy vs. a Dead Man's Millions

One day he interrupted the hearing of a will case to attend to a

*And then  
the Judge  
Remembered*



## The "Kid" Judge and One of the "Kids"



This is Judge Lindsey and his helpers hearing the story of one of the boy offenders. Notice the kindly, interested expression on Judge Lindsey's face.

newsboy, saying: "A live boy is worth more than a dead man's millions."

Through the influence of Miss Jane Addams, Chicago had the first Juvenile Court in the world, but Denver soon followed, and Judge Lindsey became the best known preacher of the new gospel—that "no child can be a criminal."

### The "How and Why" of Bad Boys

What ails a boy, then, who fights and steals and destroys property and injures others? Judge Lindsey says he is probably neglected and untaught. His father may be dead, his mother obliged to leave him all day to work. He may be willful, or he may have gotten into bad company. He may not have enough to

*Making  
The Boy  
Over Again*

eat, or clothes or books to go to school. He may need some older, wiser person to help him get work, or innocent play, to love him and listen to his troubles. That is what the juvenile court judges and probation officers do for child offenders everywhere, now. They find out why a boy is bad, and then help him to be good.

### A Brief Biography of the "Kid" Judge

The "Kid" Judge was born in Tennessee, in 1869. His father, a wealthy planter, was made poor by the war. At eleven years of age he was a "newsie" and messenger boy in Denver. At seventeen, a delicate youth, he had to help his widowed mother care for three younger children. As office boy in a law office he read the big books. He went to

night school and worked his way through college. But he always had a home and a good mother. When he became a judge he saw many boys who had neither.

#### Isn't 95% Interest in Boys Pretty Good?

Ninety-five out of every hundred children that he put on honor, never got into trouble again. Boys who just couldn't behave he persuaded to go to the reform school. He gave them money and tickets for the journey and they went alone, without guards, asking to be locked up. Once a week there was a confessional in the court room. Each boy

made his own confession. No boy was ever asked to tell on another. You know how boys despise a "snitcher." The "kid" judge despises one, too. Boys who had not even been arrested came to Judge Lindsey and owned up to law breaking. Stolen things were restored to their owners, and destroyed property paid for through the juvenile court.

Today, hundreds of honest and useful men bless the "kid" Judge for giving them a new start in life, and saving them from the disgrace of having been sent to a reformatory.

*Boys Who  
Liked to be  
Locked Up*

### The Barefoot Boy

*Blessings on thee, little man,  
Barefoot boy, with cheek of tan!  
With thy turned-up pantaloons,  
And thy merry whistled tunes;  
With thy red lip, redder still  
Kissed by strawberries on the hill;  
With the sunshine on thy face,  
Through thy torn brim's jaunty grace;  
From my heart I give thee joy,—  
I was once a barefoot boy!  
Prince thou art,—the grown-up man  
Only is republican.  
Let the million-dollared ride!  
Barefoot trudging at his side,  
Thou hast more than he can buy  
In the reach of ear and eye,  
Outward sunshine, inward joy;  
Blessings on thee, barefoot boy!*

*Oh, for boyhood's painless play,  
Sleep that wakes in laughing day,  
Health that mocks the doctor's rules,  
Knowledge never learned of schools,  
Of the wild bee's morning chase,  
Of the wild-flower's time and place,  
Flight of fowl and habitude  
Of the tenants of the wood;  
How the tortoise bears his shell,  
How the woodchuck digs his cell,  
And the ground-mole sinks his well;  
How the robin feeds her young;  
How the oriole's nest is hung.*

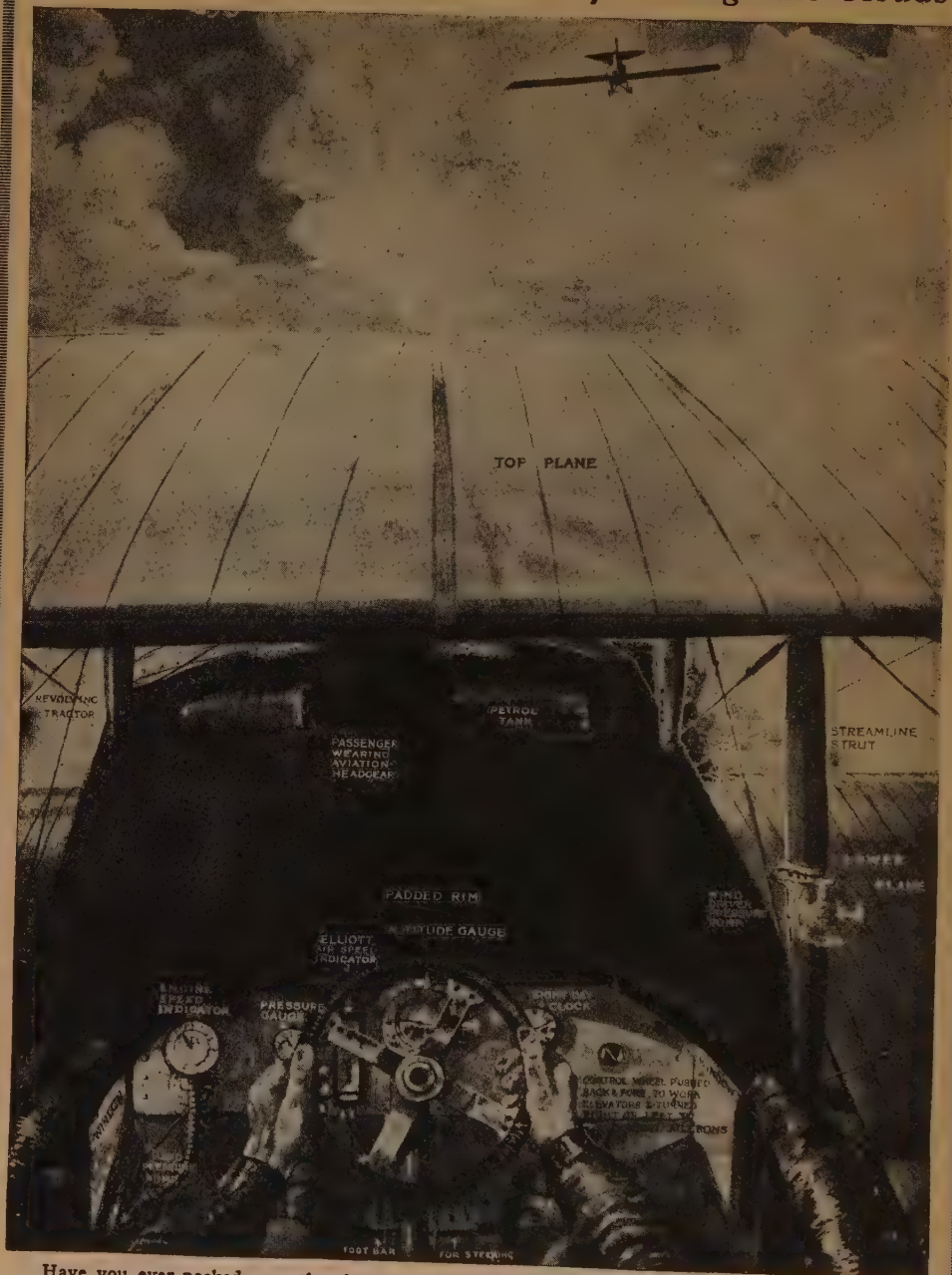
*Oh for boyhood's time of June,  
Crowding years in one brief moon,  
When all things I heard or saw,*

*Me, their master, waited for.  
I was rich in flowers and trees,  
Humming-birds and honey-bees;  
For my sport the squirrel played.  
Plied the snouted mole his spade;  
For my taste the blackberry cone  
Purpled over hedge and stone;  
Laughed the brook for my delight  
Through the day and through the night.  
Whispering at the garden wall,  
Talked with me from fall to fall;  
Mine the sand-rimmed pickerel pond,  
Mine the walnut slopes beyond,  
Mine, on bending orchard trees,  
Apples of Hesperides!  
Still as my horizon grew,  
Larger grew my riches, too;  
All the world I saw or knew  
Seemed a complex Chinese toy,  
Fashioned for a barefoot boy!*

*Oh for festal dainties spread,  
Like my bowl of milk and bread;  
Pewter spoon and bowl of wood,  
On the door-stone, gray and rude!  
O'er me, like a regal tent,  
Cloudy-ribbed, the sunset bent,  
Purple-curtained, fringed with gold,  
Looped in many a wind-swung fold;  
While for music came the play  
Of the pied frogs' orchestra;  
And, to light the noisy choir,  
Lit the fly his lamp of fire.  
I was monarch; pomp and joy  
Waited on the barefoot boy!*

JOHN GREENLEAF WHITTIER

# How the Air Man Steers His Way Through the Clouds



Have you ever peeked over the shoulder of the man who was driving an automobile? Or perhaps you have taken the big wheel in your hands yourself and gone spinning over the open roads. Does this look like the front of an automobile? For one thing the wheel is smaller and in the middle instead of at one side. The engine speed-indicator isn't very different from some speedometers. Like the automobile the aeroplane has a clock and a switch and the footbars are something like the automobile's clutch and brake. Many of the ideas in the flying machine have been borrowed from the automobile, you see.



# The Wright Brothers

## Conquerors of the Air



Orville Wright, the younger of the two most famous American aviators.



Wilbur Wright who with his brother built the first true flying machine



This \$2,500 trophy was given by the Scientific American for long distance flights in heavier-than-air machines.

**T**HERE is a Wright sister, too. When you think of Wilbur and Orville Wright, inventors of the "flying machine," don't forget Katherine Wright, who gave her brothers the money she earned by teaching and nursing, to build their aeroplane.

Now, when anyone does a very big, new thing, the world always wants to know how he came to do it, because that may help other people to do new things. An old man who knew the Wright brothers when they were little chaps has said: "I am not surprised.

They were just the kind of boys to do it. Like Edison, they were busy every minute—reading, thinking, learning something even when they played, tinkering at their sleds, kites, bicycles and a printing press. They were gentle mannered boys, honest, mod-

est, truthful, hard working, with active bodies and minds crammed full of curiosity and determination. When they began anything they finished it."

They were neither rich nor poor. Their father was a minister with a large family. They

went through high school and then through his fine library of two thousand good books. The whole family seems to be in this

*Busy Boy-  
hood of the  
Two Brothers*

story. The father loved to play and to study with his boys. When

Wilbur was eleven and Orville seven years old, he brought home a

tried coasting down a steep, snowy hillside on a box kite to see what would happen. Sure enough, it rose from the earth, sailed near the ground a little way and came down—hard.

**Putting a Heart in the Mechanical Bird**

"I'll tell you what, Buddy," said

## The Two "Bird-Men" and Their Sister, Katherine



© Underwood & Underwood.

Together these three worked and planned and dreamed to conquer the air. The picture shows them on their return from Europe, where the brothers demonstrated the practicability of their machine.

me-chan-i-cal toy. On being wound up it flew like a bat until it ran down. It was such fun to hunt through big, hard books to find out what made that toy fly. They read about the air-gliding machines of Mr. Otto Lilienthal.

Just like other boys, the Wright brothers had coasted on sleds and bicycles, or earth gliders. They had rowed boats, or water gliders. They *"A Family That Worked Together"* had sailed kites, or air gliders. Sometimes, when they had sent up a box kite on a strong wind, it had pulled them off their feet. They

one of them, "if it had an engine in it, it would keep on going."

That wasn't all it needed. In 1896 Mr. Lilienthal was killed when his engine-driven air glider came down so hard that it was wrecked. That *Learning of Bicycles, Kites and Boats* made the Wright boys,

grown men now, put on their thinking caps in earnest. The motorcycle, motorboat and automobile are all driven by engines, but if they could not be started, stopped and steered they would smash into everything, and be too dangerous.



## Caught in a Storm

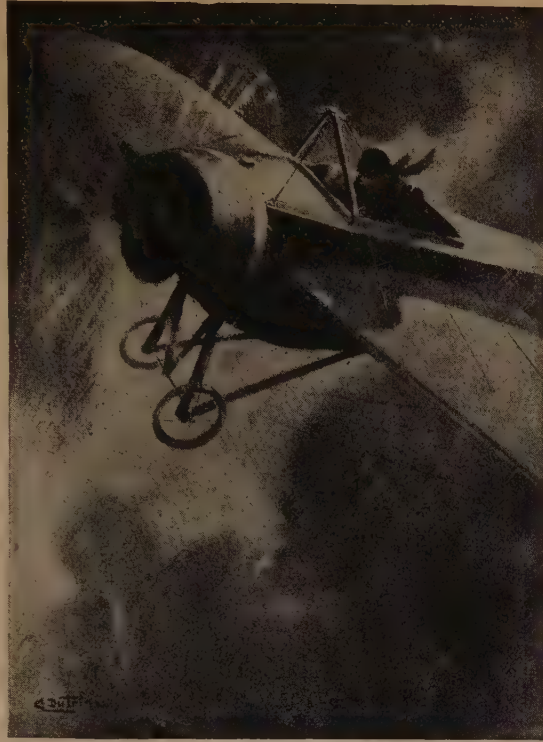
The aeroplane would be useless until it could be controlled.

### What Was Going On in the Bicycle Shop

For the next eight years the Wright brothers spent all their spare time and money working on this problem in their little bicycle shop in Dayton, Ohio. They knew that many other men, in our own country and in Europe, were trying to get the answer to that problem, too. And, oh, they were so much more likely to succeed than the Wright brothers! They had time, learning, delicate testing machines, money to build models, and powerful friends, and even governments to help them, and believe in them. The Wright brothers had only the time after work hours, no money, no laboratory and were not even well educated for their task. No one but sister Katherine and the rest of the family knew what they were trying to do, or believed that they could do it.

### How Reading Pointed the Way

One thing kept up their courage.



Storms are fearful things for the aviator. This is a French air man tearing through the wind and rain at the furious rate of one hundred and thirty miles an hour. Can you tell from the picture what type of machine he is using?

By reading of other men's experiments they came to the conclusion that everyone else was on the wrong track. With the rudest tools they made their own tests of air pressure, weight of materials, necessary spread of "wings," engine power, propellers and steering gears. They knew their aeroplane—which was a double box-kite motor-air-boat—

would sail before they made it. But if Katherine Wright hadn't given her brothers all her savings they could not have built their aeroplane, and, then, as many people who know, are saying: "We would not be sailing the air today."

It was in December, 1903, at Kitty Hawk, a lonely life-saving station on the coast of North Carolina, that the aeroplane was launched, sailed and brought to earth under perfect control. Of course the Wright brothers became rich and famous almost at once. They had kept so quiet about what they were doing that the people of Dayton learned from the

*A Surprise for the Neighbors*



# Wild Flying Machines o



Men, before they devised a successful flying machine, learned a great deal from the study of the direct imitation of the live "flying machines" were failures. It was only when man worked out succeeded.

That big word "patagial," under the sectional picture of the African flying squirrel, is simply a scientific term for the skin between the fore and hind limbs, such animals as the flying squirrel and the flying lizard.

# the Waters, Fields, and Woods



of birds, insects and other flying creatures. It must be remembered, however, that their attempts to fly by problem from the standpoint of his own circumstances and the material he had to deal with that he word meaning "winged membrane." It is applied to the fold of skin connecting the fore and hind legs of



## How Men First Tried to Fly

Men first tried to fly by making artificial wings which they operated by waving their arms up and down. This man has two sail-like devices attached to his body like wings, a parachute, and

### How Men

The Wright Brothers built the first successful flying machines with two planes. One of these planes was above, the other below the engine. The propellers were in the rear. In the latest type of machine, shown in our illustration, the propellers are in front and pull the machine instead of driving it as the Wright propellers did. The propellers of the latest type are attached directly to the engine, thus enabling the machines to attain great speed, reaching at times nearly



ballast hung from his waist in a basket. It was only after an endless number of such experiments had been tried that they found the right way to sail the air—by copying the kite, not the bird.

### Fly Today

four miles a minute. Flying machines have two kinds of rudders; horizontal rudders which control the upward movement and perpendicular rudders for turning to right and left. When you fly your kite you run very fast with it and this causes it to rise. The aeroplane rises in the same way by running along the ground into the wind on its wheels until the resistance of the air raises it.

The big machine in our picture carries twenty-two passengers in addition to two pilots, the captain and a mechanic. The place where the passengers ride is like a parlor car with seats on either side.





## THE WRIGHT BROTHERS

newspapers that in their city lived inventors who ranked with Watt, Fulton and Edison.

Money and success did not spoil them. They went right on living in the old frame house with sister Katherine, and their factory is just a big carpenter shop. No one knows which brother deserves the more credit. In speaking of their work they said "we" and "our." Wilbur died in 1912 without telling the secret, and Orville carried the work on alone.

You know how many "bird men" have met death in trying to break speed records, and in feats of skill and daring. The Wright brothers have tried to stop such foolish exhibits. All their efforts, since success, have been toward making the aeroplane safe and useful.

No brighter, cleaner chapter has ever been written in the history of invention than this of the conquest of the air; and we have only a few such stories of brotherly love and loyalty. No other country or

time can match this story of two brothers and a sister, working together, under great difficulties and

### An Aeroplane's Home on a Boat



Here is a monoplane coming back to the vessel from which it started. The first airships made their starts and landings from the land or from the water itself; it was not until later that they came and went in the air from boats. Now they are sometimes carried by battleships to do scouting.

for so long, for a great purpose, with courage, patience and faith.

## “The Building of the Ship”

“Thou, too, sail on, O Ship of State!  
Sail on, O Union, strong and great!  
Humanity with all its fears,  
With all the hopes of future years  
Is hanging breathless on thy fate!  
We know what Master laid thy keel,  
What workmen wrought thy ribs of steel,  
Who made each mast and sail and rope,  
What anvils rang, what hammers beat,  
In what a forge and what a heat  
Were shaped the anchors of thy hope!  
Fear not each sudden sound and shock;  
'Tis of the wave and not the rock;  
'Tis but the flapping of the sail,  
And not a rent made by the gale!  
In spite of rock and tempest's roar,  
In spite of false lights on the shore,  
Sail on, nor fear to breast the sea!  
Our hearts, our hopes are all with thee,  
Our hearts, our hopes, our prayers, our tears,  
Our faith triumphant o'er our fears,  
Are all with thee,—are all with thee!”

—Longfellow.

## SOME OF THE WORLD'S HELPERS

### The Story of an Aviator Who Became a World Hero

**I**T took Christopher Columbus sixty-nine days to cross the Atlantic Ocean, but Charles Lindbergh crossed it in thirty-three and a half hours—less than a day and a half! Not in one hundred years has the western world been so thrilled over a deed or over a youth.

Shortly after the valiant French fliers, Coli and Nungesser, had disappeared in a similar trip across the ocean, when weather conditions were so adverse that such splendid aviators as Commander Richard Byrd and Clarence Chamberlain were waiting for better reports before starting over, Lindbergh set out alone in a single engined monoplane for Le Bourget Field, Paris, and landed there safely on a dark night about on schedule time! Is there any wonder that he won the admiration of everyone and the title of "The greatest sportsman in the world"?

#### The Natural Result of Such a Deed

Regardless of the type of man, the first one to cross the Atlantic alone, without stopping, would naturally be the center of the world's attention for a brief space of time. He would be decorated with medals of bravery and receive many flattering offers to go on the stage or in the movies,

and then a murder or scandal would break out and the world would forget all about him.

#### Lindbergh's Story Different

Lindbergh's story is an entirely different one. Instead of the world forgetting very soon, his popularity increased all the time. The flight itself was remarkable, but the personality and character of the boy who made it was more so. It reached out and won the hearts of the French people as soon as they saw him and the more they saw him, the more enthusiastic they became. The same thing happened in the other European countries he visited and in America. Usually when a person becomes such a great hero that everything he does and says is made public, he will be sure to do or say something that people will object to or criticize; but Lindbergh, without seeming to make the slightest effort, has remained the ideal hero and has done or said nothing to disappoint.

Now, why is this? What of this youth, his boyhood, his hopes, his aims, and his beginnings in the air? In his appearance he is a lanky, six-foot blond, strong and ruddy looking, with an engaging smile. He reminds

*Why Lindbergh's Story is Different*

*Alone and Under Most Unfavorable Conditions*

*His Appearance*



AN AVIATOR HERO

## The Columbus of the Air

*His favorite pose.*



Colonel Charles A. Lindbergh, who made the first non-stop flight across the Atlantic.

one of an ancient Viking; but so boyish and youthful-looking that it sounds strange to hear him called "Colonel." His eyes are china blue and so clear and fine that they seem to reflect the higher altitudes where he spends so much of his time.

#### **Lindbergh's Early Life and Education**

Charles Lindbergh was born in Detroit, Michigan, on February 4, 1902. When he was less than two months old, he was moved to his parents' farm near Little Falls, Minnesota, where his father was practicing law.

His father was born in Sweden, but at an early age moved to America, where he received his education. He graduated in law at the University of Michigan and for ten years represented his district in

*A Noble  
Heritage*

Congress. It is said the relationship between father and son was very close. The father died in 1924.

Lindbergh's mother was Evangeline Land of Detroit. She is of Irish descent, a woman of great modesty and charm. She is a graduate of the University of Michigan and Columbia University, New York.

"Slim," as Charles was often called, attended school, both in Washington and Little Falls, wherever the family happened to be. In 1918, at the age of sixteen, he graduated from the Little Falls High School. His mother says he was an indifferent pupil at school, not studying very hard in those subjects which did not interest him. He

*Was Always  
Tinkering  
With Things  
to See What  
Made  
Them "Go"*

liked mathematics and mechanics and was always tinkering with things to make them "go." He did not take much interest in English and Grammar, but he had pride

enough to make very good grades in them. Little did he realize then that he would some day be called upon to write, on short notice, a book containing the story of his life; but so thoroughly did he master his English that when the occasion arose he could write a book, well constructed in every respect.

His interest along scientific and mechanical lines caused him to decide to take a course in mechanical engineering at the University of

*Develops  
Interest in  
Aviation  
While in  
University*

Wisconsin. While there he became intensely interested in aviation, and in his third semester, decided to study aero-

nautics in earnest. He was so accustomed to spending his time out-of-doors that he found the studying at the university very trying. His chief recreation consisted of shooting-matches with the rifle and pistol teams of rival universities, and in running around on his motorcycle.

#### **He Leaves the University**

"Slim" became so interested in aviation that after finishing the first half of his sophomore year, he left the university for Lincoln, Nebraska where he enrolled as a flying student with the Nebraska Aircraft Corporation. His instructor, who had the name there of being the most "hard-boiled" one in the World War, soon found in "Slim" an unusually apt pupil. He had "air sense."

*Enrolls in a  
Flying School*

After several months' training, which included about eight hours of instruction, "Slim" had progressed so rapidly that his instructor pronounced him ready to go up alone; but because he could not furnish the bond required to cover possible damages, he was not allowed to go

up. He felt that he could fly successfully without any bond, so he left the school, and from that moment was "on his own."

#### He Starts Out Into the World

About this time the Nebraska Aircraft Corporation sold the instruction plane that "Slim" had been using to a man planning to make "barnstorming" trips through southeastern Nebraska. Lindbergh offered to pay his own expenses if he were allowed to go along as a helper and mechanic. "Barnstorming" is the word the aviator uses for flying trips made from one town to another for the purpose of taking up any "air minded" passengers. In 1922 the fare usually charged was five dollars per passenger for five or ten minutes' ride.

While on this trip, "Slim" began to do a little "wing walking," or standing on one of the wing tips while flying low over a town. This often helped to attract a crowd. In June he returned to Lincoln for a little more instruction, and while there he perfected the art of parachute jumping.

In the summer and fall of 1922, we find him barnstorming in western Kansas, eastern Colorado, Montana and Wyoming. It was in these days that he learned his control of planes. He flew any plane that was offered to him and became known through the west for his daring stunts. He did the "falling leaf," the "Immelman turn," "barrels," "spinning nose dives," "rolls," "loops" and cart wheels"—everything that thrilled an audience. Not only that, but he made perfect land-

ings. Whatever he did, was done well. He saved what he earned, and neither drank nor smoked.

#### He Buys a Plane

Lindbergh was saving his money to buy a plane. How he longed for one for his very own! In March, 1923, this dream came true when the army had a salvage sale of old planes at Americus, Georgia. The array was not very tempting; but "Slim" found one that appealed to his needs and his purse and became the proud possessor of a plane.

After he had tinkered with it to his heart's content, he started barnstorming again, going to county fairs, doing stunts and paying his expenses by taking up passengers.

In the course of his traveling it was only natural that "Slim" should come across newer and better planes. His fingers positively itched to get hold of some of these newer, higher powered models! He knew the best place to get a chance to handle these was in the army, so he began to think of enlisting.

#### Sells His Plane and Enters Army

"Slim" sold his plane and in March, 1924, enrolled as a cadet in the army's primary training school at Brooks Field, San Antonio. There were a hundred and three others in his class, but he soon became the "ace" of them all. From Brooks Field, the boys were transferred to Kelly Field for their final training. The requirements and instructions there are so rigid that only a small per cent graduate. Lindbergh was one of eighteen out of the number to graduate and receive his wings. He graduated as a reserve second lieutenant in the army air corps.

*Learns His Control of Planes*

*Wing Walking and Parachute Jumping*

*The Ace of His Class*

*Barnstorming Again!*



Nine days before his graduation, "Slim" became a member of the famous "Caterpillar Club." This is

*Joins the  
Caterpillar  
Club*

one of the most exclusive clubs in the world, because the only way for one to become a member is to save his life by jumping from a falling plane in a parachute. Since that time, Lindbergh has done that on three other occasions, establishing a most unusual and remarkable record. It takes a very cool, rapid thinking brain to do this successfully. They call it the "Caterpillar

*How the Little  
Silk Worm  
Caterpillar  
Saves Many  
Lives*

Club" because the parachute is made entirely of silk, and silk comes from caterpillars. The members of this club, which numbers fifty-seven in 1927, feel that their lives have been saved by the little silk worm caterpillar!

#### After Graduating from Kelly Field

After his graduation from Kelly Field, Lindbergh went to St. Louis, flying any plane he could get, and doing stunts. He made another round of barnstorming and after this returned to St. Louis and joined the Missouri National Guards, 35th Division Air Corps, and by December, 1925, was promoted

*Captain at  
the Age of  
Twenty-three*

to captain of the 110th Observation Squadron. He was then twenty-three years of age.

Lindbergh decided he wanted to be an air mail pilot and secured the position of chief pilot for the Robertson Aircraft Corporation, with full power to select the other pilots

*He Becomes  
an Air Mail  
Pilot*

and the nine landing fields between New York and St. Louis. On April 15, 1926, he inaugurated the air mail between Chicago and New York.

His plane was christened "St. Louis."

Those who knew "Slim" Lindbergh then are high in praise of his pluck in the air; but he is also remembered by them for his daring motorcycle riding. He flashed around like a comet, it is said.

"He's never afraid to take a chance," his comrades have said of him. On stormy nights when other pilots, having given up hopes of flying, would "turn in" for the night,

*"Danger  
First"*

"Slim" would don his flying togs, and in a matter of fact tone say, "Well, boys, I'm going through," and weather or no weather, he "took off," as the aviators say when they

*Could Be  
Depended  
Upon*

fly. He established a reputation for doing on time what he set out to do. He spent much of his time alone and loved it, but he, also, loved his comrades and had a faculty for winning friendships. He was fond of playing pranks and jokes. Another thing he was very fond of was eating. In fact, he admitted once that it was his "long suit." When he sits down to breakfast he calls for half a dozen eggs and a chop or steak.

*Loved Pranks  
and Jokes*

#### Planning His Paris Flight

It was while flying the mail one night in the fall of 1926 that "Slim" first considered the possibility of the New York-Paris flight. A prize of \$25,000 had been offered in 1911 by Raymond Orteig for the first non-stop flight between New York and Paris. The more he thought about it, the more determined he became to make it. He felt sure he could do it. At once he set to work to secure financial backing, which he

found in some public spirited men in St. Louis. He was nothing if not thorough, so he first went to New York to obtain more information regarding planes, motors, and other details of the flight. He gave the most careful consideration to the kind of plane best suited for such a trip.

*He Secures  
Financial  
Backing*

#### Selecting a Plane

He finally chose a Ryan monoplane which he had made specially for him at the Ryan factory in San

equipment had, also, to be taken into consideration. One interesting feature of this consisted of a collapsible rubber boat, known as an "aircraft," which could be inflated in a few seconds with two small bottles of carbon dioxide, handily placed. The boat was carried back of the pilot's seat. There were light oars in it and it was to be used in case of a forced landing.

*Carries an  
Air Craft  
Boat*

The few people who referred to Lindbergh's flight as a "daredevil"

### The "Spirit of St. Louis"



Colonel Lindbergh's only companion on his famous flight.

Diego. It was driven by a Wright Whirlwind air-cooled radial motor of two hundred horsepower, rated with a high speed of one hundred and thirty miles an hour and with Pioneer navigation instruments, including earth inductor and compass.

He called it the "Spirit of St. Louis" and it was unusual in that it was a "blind" plane. The pilot had no direct vision ahead, but in order to enable him to see directly ahead, a sliding periscope, said to have been the first ever designed for aeroplane use, was built into the ship.

While planning the plane, its

stunt did not know of these endless hours of thought spent in preparation. It was not a stunt or an accident, or a bit of luck, but a triumph of faith, skill, planning, daring and determination.

*Painstaking,  
Thorough  
Preparation*

#### "Spirit of St. Louis" Starts for N. Y.

On April 28, 1927, the "Spirit of St. Louis" was completed, and after testing it thoroughly, Lindbergh set off on May 10 from San Diego Field for St. Louis, a distance of 1,550 miles. He made it in fourteen hours and five minutes, the longest non-stop flight ever

*Establishes a  
New Cross  
Country  
Flight Record*

made across the country by one man. The very fastest mail journey would have taken seventy hours!

The next day "Slim" left St. Louis for Curtis Field, New York, making in seven hours and twenty-five minutes a journey that would have taken the fastest train twenty-four hours! Here the "Spirit of St. Louis" was made ready for her flight across the Atlantic.

### Paris Bound

Before dawn on May 20, "Slim," with about four sandwiches tucked away in his plane, went to Roosevelt Field with all preparations completed for the final journey. History has produced few moments more dramatic, yet there were neither crowds nor bands to do it honor. Lindbergh had kept it so quiet that only a very few knew about it; but these few were thrilled and awed at the sight of this young pioneer of the air, unmindful of the danger, calmly taking his life in his hands—gladly risking all for a great ideal!

Clarence Chamberlain, who with Commander Byrd and the rest, were watching with great fear in their hearts, cried out: "The man who lives through the hell of that single point and doesn't decide to cut his gun and stop his plane, may get into the air, or he may go over the bank, but there'll never be any doubt of his courage."

### What Impressed the People Most

But it was not so much the fact that Lindbergh did what he set out to do as the manner in which he did it, that impressed people the most. From the moment he set foot on French soil, people almost went

### Lindbergh With the U. S. Ambassador to France



Ambassador Herrick treated Charles Lindbergh as a father would treat a beloved son who had done well. He is here seen with his arm affectionately over the shoulder of "Our Boy."

wild over him. They could not have done more for one of their own sons, and at the very time when they were grieved over the loss of their own men who had gone down attempting to cross the Atlantic. Lindbergh was truly an ambassador of good will at a time when it was sorely needed.

The first thing he did next morning was to telephone to his mother in Detroit, and then he visited the mothers of the noble French fliers who had gone down.

Emerson once said that five minutes' conversation was long enough for him to understand some people,

Youth's  
"Superb  
Gesture"

Ambassador  
of Good Will

Telephones  
His Mother



## Wins Distinguished Flying Cross



President Coolidge bestowing the Distinguished Flying Cross upon Colonel Charles Lindbergh before a distinguished assemblage at the Washington Monument.

but it was not necessary to have that much with Lindbergh. When he first landed and spoke of "we," he not only coined a flying pronoun, but showed such modesty as the world has seldom seen, giving his machine full share in all that he did. In the first few weeks alone "Lindy" received over three million letters; offers for making money amounting to more than eight million dollars. For instance, one movie concern offered him \$240,000 for not more than forty minutes of his time, if he would merely stand in front of a camera and read the first account of his flight as it was published in the New York "Times." He quickly refused. In fact, he did not even look at most of these movie offers, much less consider

*"We"—a  
Partnership  
Between a  
Man and a  
Machine*

*Refuses All  
Offers to  
Commercial-  
ize His Trip*

them. Always he would reply, "I am an aviator, not a movie star." The only contract he signed was for writing a book, "We," telling the story of his life. His flight was made in the interest of aviation and he would not take advantage of it to make money along these other lines.

#### How Europe Received Him

He was invited to all the European capitals and was very eager to visit them, but this opportunity was denied for lack of time and he only had time to go to Belgium and England before the cruiser "Memphis" was sent by President Coolidge to bring him home.

During the time he was abroad, he was treated royally everywhere. Medals of valor were pinned on him. He was constantly entertained by

*European  
Capitals  
Shower Him  
With  
Invitations*

the most distinguished people, and received numerous gifts.

**Our Hero Comes Home**

"Lindy" had not thought that anything could surpass his welcome abroad, but it is said that America gave him the greatest welcome ever received by any man in history; certainly the greatest in numbers and in kindly emotions, in which there was no trace of jealousy.

President Coolidge invited his splendid mother, Mrs. Evangeline Lindbergh, to come to Washington and be entertained with her son at the White House. She was allowed to greet him first when his steamer landed.

Long before it landed, his official welcome began. Scores of airplanes flew overhead. Dirigibles and many ships went to meet him.

*A Welcome Not Equalled in Our History* The President's salute of twenty-one guns was exchanged. A group of cabinet members and high officials waited for him on the shore. People were everywhere. There were brass bands and cheering, and at the Washington Monument a speech by President Coolidge welcoming him, and pinning upon him the medal of the Distinguished Flying Cross. Everything fine that could be said of anyone was said by our highest officials in Washington, New York and St. Louis; but nothing turned his head. To all of the speakers, his

*He Kept His Head*

replies were short, simple and modest, taking little credit to himself. People clapped for him until their hands were numb, and one radio announcer was so overcome that he broke down and sobbed. Col. Lindbergh received carloads of gifts, ranging from the simplest things to the most expensive.

**New York Honors Him**

It would not be possible in this space to do justice to his entertainment in New York, or in Washington. Never in all history has anyone been so received and honored by the people of our country's largest city. New York gave him the largest dinner it has ever given to anyone. It took place at the Hotel Commodore and when "Lindy" came into the banquet hall, the people all became so excited that many perfect strangers found themselves hugging each other. Not only had he set the world on fire, but he kept the fire burning.

**The Greatest Thing Lindbergh Did**

Lindbergh could not have won the world as he did had he been arrogant or conceited; but the fact that he was as clean in character as he was strong in body; that he put his ideals of aviation above any desire for wealth; that he was as modest as he was courageous—these kept the fire going. They are the things we all honor most. In fact, it is this, more than his flight, that has brought to Colonel Lindbergh the distinction of the "World's most admired hero." Someone has well explained the effect Lindbergh has on people in these words, "He personifies what all of us would like to be and do."

*Every Man's Ideal*

Truly his glory and heroism are for all men. An apparently impossible task loomed before him and he did it. Since his return, he has continued to put all of his best efforts into getting people more interested in commercial aviation. That is all he talks about.

In answer to a speech made by General Courand of France, Lind-



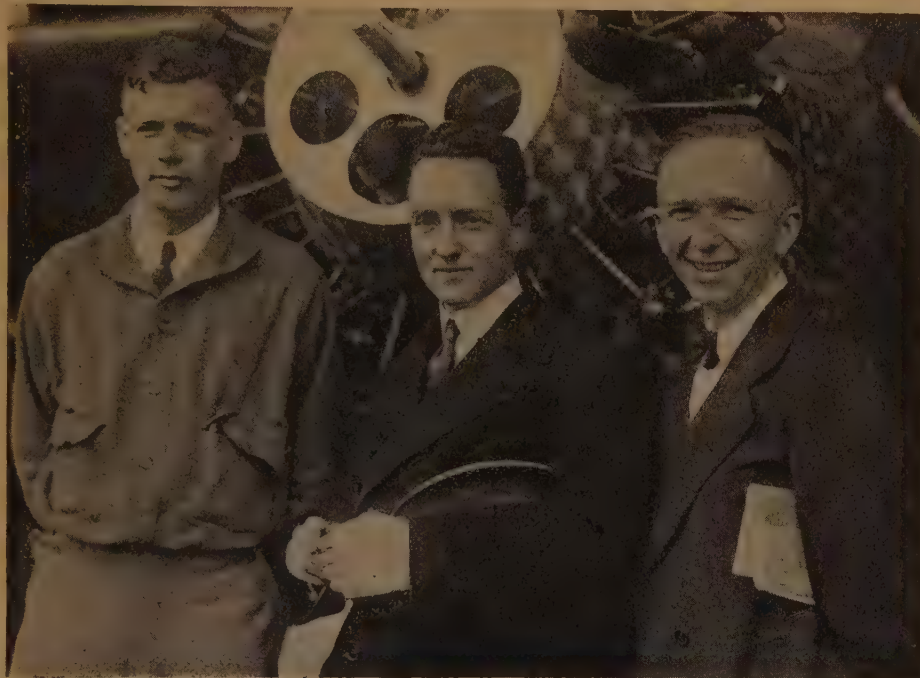
## Lindy's Ride Through Lower New York



No, it isn't a snowstorm, but myriads of paper and streamers of ticker tape showered in honor of Lindbergh in New York City. Thousands of people crowded the street from the curbs to the building fronts to catch a glimpse of the flyer, or to shout their greetings to the daring pilot of the "Spirit of St. Louis."



## Three of America's Foremost Aviators



Many of the things written in this article about Lindbergh might as well be said of these other two brave aviators. Commander Richard Byrd was the first man to fly over the North Pole, for which he was awarded the Congressional Medal of Honor. Clarence Chamberlain, with one passenger, was the first to make a non-stop flight to Germany.

Lindbergh tells how he feels about his trip to Paris, and gives an idea of the progress of aviation. He said: "Gentlemen, 132 years ago Benjamin Franklin was asked, 'What good is your balloon? What will it accomplish?' Today those same skeptics might ask me what good has been my flight to Paris. My answer is that I believe it is a forerunner of a great air service from America to France, America to Europe, to bring our people nearer together in understanding and friendship than they have ever been."

*What Good Was His Flight to Paris?*

*For Greater Progress in Aviation*

Lindbergh had this to say on aviation:

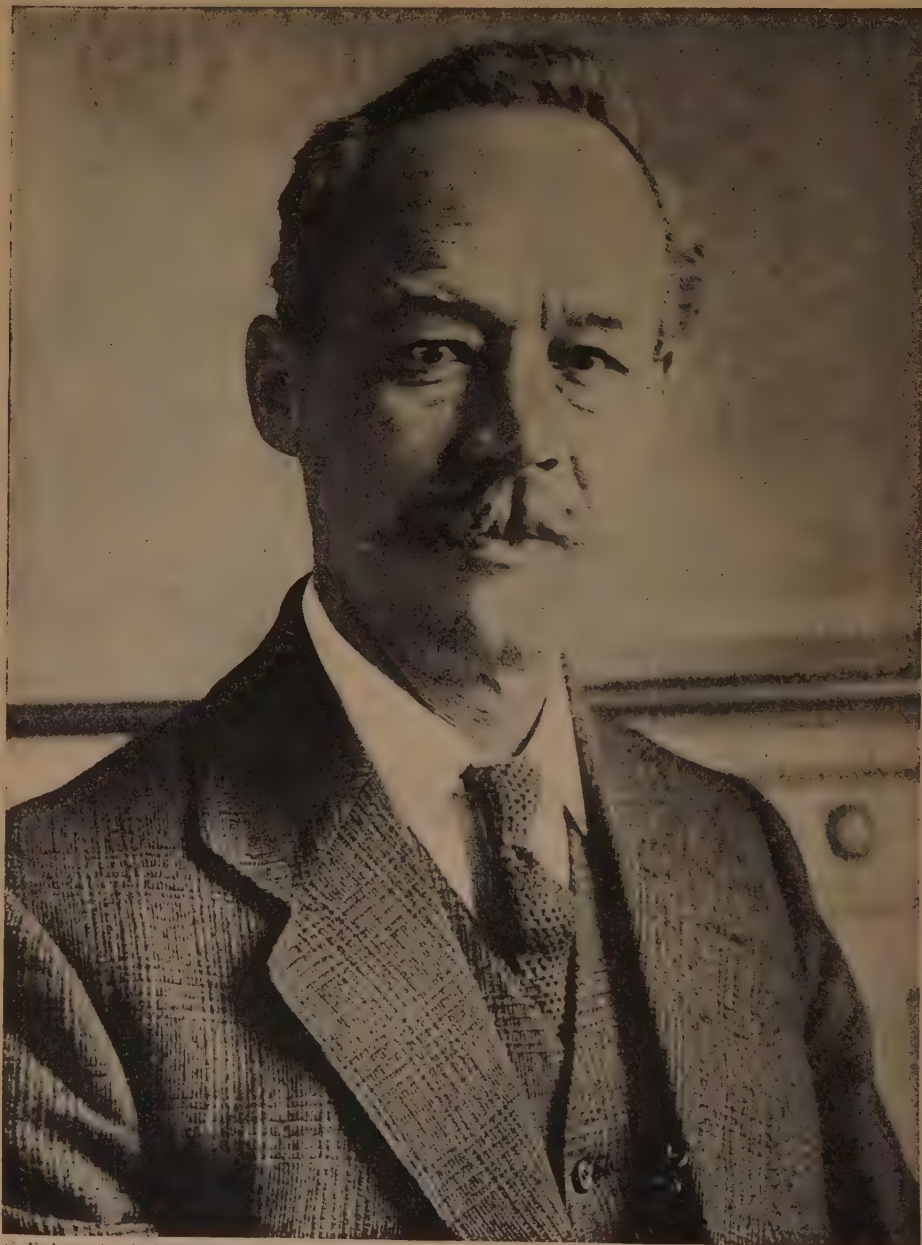
"What we need now more than any other one thing is a series of airports in every city and town throughout the United States. Given these airports, in a very few years the nations of Europe would be looking toward our passenger lines as they now look at our mail routes."

*We Need More Air Ports*

Longfellow had no knowledge of Lindbergh's journey when he wrote "The Building of the Ship," but what he says there of the future of navigation might apply as well to Lindbergh, his "Spirit of St. Louis" and the future of aviation.

In a speech in Washington Colonel

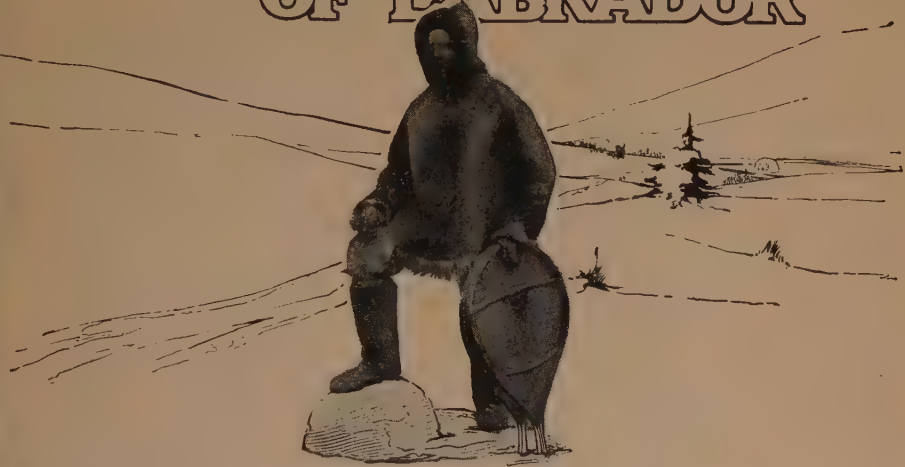
## The Doctor Knight of Labrador



© Underwood & Underwood

"He set broken legs, dressed gunshot wounds, cured fever. As a minister he buried the dead, and married the young. He started a traveling library. And he brought Christmas to the children."

# THE DOCTOR KNIGHT OF LABRADOR



© Brown Brothers

"People felt better just to see the big, funny bear of a jolly doctor in his Eskimo clothes."

**Y**OU know what a knight is. In old tales of chivalry, the hero put on his armor and rode away to fight bad men and defend fair ladies. After a brave deed he was knighted. The King touched his shoulder with a sword, as he knelt, and said: "Arise, Sir Knight." His title was a sort of hero medal.

Men do not have to fight in that way, today, but they battle against other kinds of evils. They spend their lives in loving service to the poor, the sick, the ignorant and lonely. Painters, sculptors, writers, explorers, men of science, inventors, engineers, help to make the world a better and pleasanter place to live in. In countries where there are kings,

men are still being knighted for useful, brave, and kind deeds. A few years ago a medical missionary of far away frozen Labrador knelt before King Edward of England. The King touched his shoulder with a sword and said:

"Arise, Sir Wilfred Grenfell."

Then the ladies and gentlemen of the proudest court in the world crowded about a poor doctor of fisher folk, to ask about his dangerous and lonely work. They gave him money to build two hospitals, to buy a swift steam yacht, and to get a herd of reindeer from Lapland, the only milk-giving and big draught animals that can live in Labrador. As an English knight he was able

*"Soldiers of  
the Common  
Good"*

*Winning  
Friends at the  
King's Court*



to make his mission better known, and to take greater comfort to the people of a desolate land.

#### Gave Up London for Labrador

Some of the people of Labrador are Eskimos. They can supply their few needs of food, fuel and shelter. But in the fishing villages along the coast there are English and French Canadians. For nine dark months in every year they are frozen in. The ships cannot come and there are no railroads. Doctors and ministers from Newfoundland were afraid to travel with dog sledges. In 1892, news too good to be true spread through the fishing fleets, along three thousand miles of coast, and back to the huts of fur trappers. Dr. Grenfell, a London surgeon, was coming to live and work in Labrador.

In the summer he uses a little steamer, stopping in any harbor where a flag flies. Icebergs, flogs, gales, fogs and jutting crags make every voyage perilous. Winter journeys are still more dangerous. At first he had only a spruce log sledge, with the jaw bones of a whale for runners, pulled by a string of Eskimo dogs. There were no roads.

#### The Jolly Saint That Dressed Like a Bear

But oh, what things he saw, what suffering he relieved in bare, dark, cold little huts! People felt better just to see the big, furry bear of a jolly doctor in his Eskimo clothes. He set broken legs, dressed gunshot wounds, cured fevers. He got wheeled chairs for the paralyzed; crutches for the crippled. The first wooden leg ever seen in

*Perils of the  
Land of  
Eternal Snow*

*The First  
Wooden Leg  
in Labrador*

Labrador made a useful man of a helpless boy. Crooked backs and lame hips were cured in the hospitals. Injured fishermen were mended. Herds of reindeer gave milk to children, and made traveling easier.

#### And He Played Santa Claus, Too!

More than that, he brought joy to cheerless lives. As a minister, he buried the dead, and married the young. He started a traveling library. And he brought Christmas to the children. Magazine and newspaper articles and letters he wrote brought boxes to him from many countries. Boxes of gifts were sent to the most distant cabins. In St. Anthony he dressed as Santa Claus, and drove up to the little village church with a team of reindeer.

What a wonderful, fairy-tale time it was! There were little girls who had never seen a play baby or tea set; boys who had never owned a *Santa in* jackknife or ball; old *Reindeer Land* people who had never eaten candy. No one at all of all those poor fisher folk had ever dreamed of such a glittering tree! Months afterwards he saw one of the Christmas dolls hanging on the wall of a bare hut.

"Why don't you play with your baby doll, dear?" the doctor asked the little mama.

#### A Doll Too Sweet to Play With!

"Oh, she's too swe-e-et and be-autiful to hold. I must keep her forever to look at."

If you want to help this brave, true knight keep Christmas, send your gift in the summer. The tiniest thing would make some child happy. Address it to Doctor, Sir Wilfred Grenfell, Battle Harbor, Labrador.

*And You  
Can Help  
the Doctor*

# Burbank, the Plant Wizard



This is  
Luther  
Burbank  
himself  
seated  
beside  
a big  
spineless  
cactus

Photograph  
by Paul  
Thompson

ONCE there was a boy who loved plants. Do I mean animals? You can understand any one being fond of *animals*, for they learn to love those who care for them. But any florist, gardener or farmer can tell you that plants repay wise and loving care, by giving their biggest, finest fruits and flowers. Not so very many years ago, people thought in farming and gardening all they could do was to plow land, put in seeds and keep the weeds down. The rest was just weather and luck. So some very useful and beautiful plants dwined

*The Boy  
Who was  
"Kind" to  
Plants*

dled and pined away, because no one knew what more to do for them. Farmers said the seed "ran out." They did nothing about this until a bright boy waked them up.

It was in Lancaster, Mass., where Luther Burbank was born in 1849. Most New England boys became sailors—"far countries for to see," or they went

to California to dig gold. At sixteen

Luther was not strong enough to go to sea, or to "rough it" in a mining camp. He had to stay at home, and do the humdrum tasks of a poor farm. There

*The  
Romance  
of Farm  
Life*

is no romance in plowing a scanty corn field or digging a meager crop of potatoes—unless you have imagination.

### Story of the First Roasting Ears

Luther Burbank had. New England seasons are late. There were few green things in the gardens before July. In Fitchburg well - to - do

people would pay good prices for early vegetables. He surprised everyone by bringing in a wagon load of "roasting ears," two weeks ahead of anyone else. The secret of it was that he selected large, plump seeds and sprouted them in manure and leaf mold before planting them. His corn was "up" the next morning. He pulled the weaker plants with the weeds, and then plowed and plowed. His corn grew fast and tall, with many ears to the stalk.

### How He "Invented" His Big Potato

Next he turned his attention to potatoes. They had "run out" giving only a few small ones in the hill.

Poor little discouraged things! He would do his best to help them grow bigger and more plentifully. It took him four summers of back-breaking work, and four long New England

winters of patient waiting. But the whole country was excited when the big Burbank potatoes were put on the market for seed. His crop was sold for enough money to take him to southern California, the plant paradise. There, while working as a farm hand, and growing strong in the sun, he studied plants.

### How the Wizard Works in His Nursery

He found that some plants were naturally better than others of the same kind, and *wanted* to be helped. Careful seed selection, rich soil, cultivation, and not allowing bugs to bite them will improve plants wonderfully. But to grow new varieties this plant friend had to play honey bee. He lifted the pollen from the blossom of one kind, on a camel's hair brush,

and carried it to the wet button of the seed tube of another. This is called "crossing." By crossing a common red poppy with a red striped yellow one he grew the big, crimson poppy. A way in which he helped fruit was by grafting twigs of a fine variety that is scarce, onto a vigorous old tree. He sometimes grafted one thousand varieties of apples on one tree, by cutting out grafts that disappointed him. He worked patiently for years, for a cer-

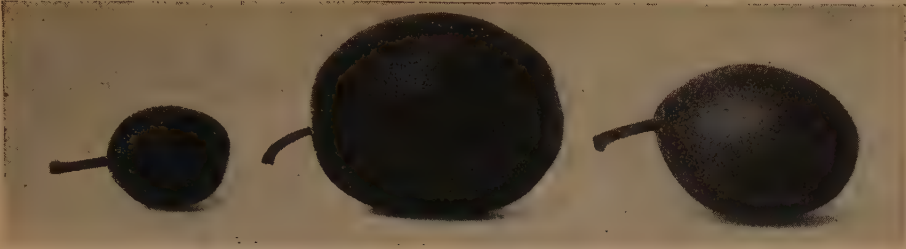


The Burbank "White" Blackberry.

Playing  
the "Honey  
Bee"

Encouraging  
Discouraged  
Potatoes





The Big Stoneless Plum and the Two Kinds of Plums from Which It Was Developed.

tain size, color, flavor or firmness of fruit, or to reduce the seed.

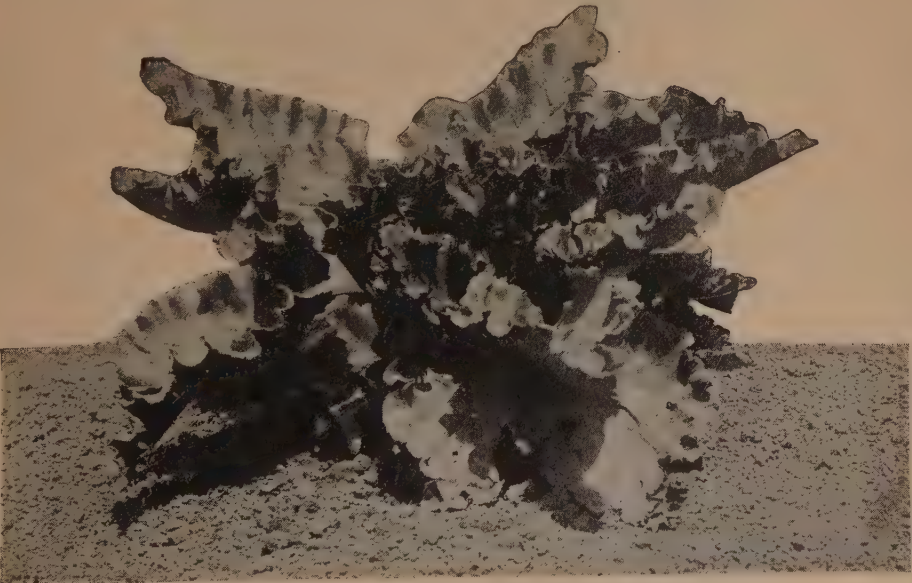
This "plant wizard" as he was called, had no secrets. He told other men just how he worked to get his wonderful results. About forty of his improved plants became known. But he grew over twelve hundred others that the world knows very little about. You see he had no money to publish reports. As his discoveries were too important to be lost, the Carnegie Institute set aside one hundred thousand dollars to help carry on his experiments. Congress gave him the use of government land on which he grew the

spineless cactus that cattle can eat.

Mr. Burbank was not rich, but he added millions of dollars a year to the value of our field, orchard,

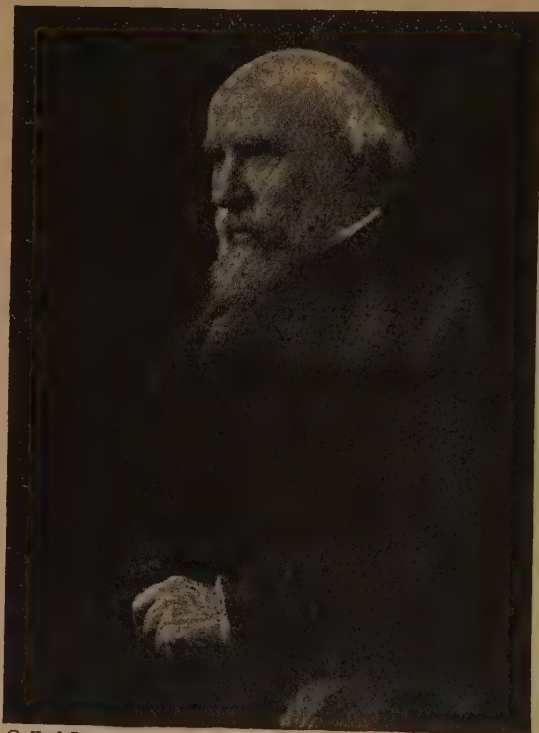
*And You  
Can Find  
Such Fortunes  
in Your  
Cornfield*

garden, forage and timber crops. One of the greatest helpers of men that ever lived, the pathway to his door was worn smooth by pilgrims who went to honor him and learn of him. Don't you wonder if any Lancaster boy who ever went to sea or dug for gold, found greater good fortune, or a happier, more useful life than Luther Burbank found in his corn fields and his hills of "run out" potatoes?



Burbank's Ever Bearing Rhubarb.

## Mr. Hill and How He Wrote His Name



© Koch Bros.

*Geo. J. Hill*

## James J. Hill, the Colossus of Roads



Here is Mr. Hill standing in the doorway of the cab of one of his own big locomotives.

**I**N the story of the "Seven Wonders of the World," you can read about the giant figure of a man that was called the Colossus of Rhodes. When Mr. James J. Hill finished the Great Northern Railroad, some witty person changed the spelling to "roads," to make the name fit our greatest railroad builder.

### Little Jim Hill's Fondness for Good Books

Little "Jim" Hill never dreamed of winning such a nickname, when he was a boy on a farm in Ontario, Canada. He

had a Scotch mother who wanted her dear, book-loving laddie to be a doctor. When he grew up, and was living in St. Paul, Minnesota, he offered himself as a soldier, to fight in our Civil War, but Uncle Sam could not accept him. Two sad misfortunes, in

*The Studious  
Hard-Work-  
ing Scotch Boy*

childhood, spoiled both plans. First a playmate struck him with an arrow, making him blind in one eye, when he was nine years old, so he could not be a soldier. When he was fifteen his father died, and he had to leave



school. In 1856, at the age of eighteen, he came to St. Paul to clerk in a Mississippi River steamboat office. It is a big city today, with a thickly peopled country behind it, but then it was only a struggling pioneer village "at the far end of nowhere." The Scotch Canadian youth worked hard all day, and studied half the night. He learned such a variety of things, and knew them so well, that he could write an encyclopedia. In his railroad building he found use for everything he knew.

**They Laughed at First, of Course!**

Firewood was cheap in Minnesota, and everybody laughed when "Jim" Hill brought a boat-load of coal from Illinois. But he sent that coal in wagons to the Red River and sold it in the Canadian town of Winnipeg. People laughed again when he bought an unfinished, bankrupt railroad, that had "crawled four hundred miles out on the prairie to die." But in six years, and that was in 1885, he was president of a good road that was making money.

**Then Capitalists Began to Believe in Him**

In that day, what wheat and

lumber came from the Northwest had to go across Canada, by the Canadian Pacific, or down to Chicago by the Northern Pacific. Mr. Hill saw how a thousand miles of

Speaking to a Gathering of Farmers



This picture shows Mr. Hill delivering a speech to the farmers along his lines, in which he is emphasizing the need of better farming methods.

rail freight could be saved, if a road were run between these, and Puget Sound connected with Lake Superior. That would save money on the long haul to Buffalo, for water travel is cheaper than land. He made men with money believe in his plan, although neither of the other roads were making profits. Look where the "Great Northern" runs, from Duluth to Seattle, with the cities and towns

strung along it. That road was pushed through the wilderness—through "the land of sky blue water" of Minnesota, the prairies of Dakota, along the big muddy Missouri, over wild mountains and deep canyons.

**A Line that Reached Half Way 'Round the World**

When it was finished in 1893, people poured in, and wheat poured out. Lumber camps and mines were opened. Grain elevators rose like lighthouses, above the sea of grain; cattle and sheep ranged a





"IN THE PAGES OF GOOD BOOKS  
LIES THE MAGIC TO INSPIRE OUR  
DREAMS AND THE POWER TO MAKE  
THOSE DREAMS COME TRUE"







